Judul **Your Login Details**

Dari: mts@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Tanggal: Senin, 27 Maret 2017 16.46.41 WIB

Dear Dr. Gribaldi Gribaldi,

An account has been created for you to access the Manuscript Tracking System for manuscript submission and review. The main page is located at http://mts.hindawi.com/.

If you have any problems logging in, please let me know.

Sincerely,

System Administrator
Hindawi
http://www.hindawi.com

Your Login Details

Dari: Hindawi (mts@hindawi.com)

Kepada: gribaldi64@yahoo.co.id

Tanggal: Senin, 27 Maret 2017 16.46 GMT+7

Dear Dr. Gribaldi Gribaldi,

An account has been created for you to access the Manuscript Tracking System for manuscript submission and review. The main page is located at http://mts.hindawi.com/.

If you have any problems logging in, please let me know.

Sincerely,

System Administrator
Hindawi
http://www.hindawi.com

Judul **9734036: Acknowledging Receipt**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: sahl.abdelrahman@hindawi.com; lelinurlaili66@gmail.com; rujito62@yahoo.com
Tanggal: Senin, 27 Maret 2017 18.13.47 WIB

Dear Dr. Gribaldi,

The Research Article titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress," by Gribaldi Gribaldi, Nurlaili Nurlaili and Rujito Agus Suwignyo has been received and assigned the number 9734036.

All authors will receive a copy of all the correspondences regarding this manuscript.

Thank you for submitting your work to International Journal of Agronomy.

Best regards,

Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com

9734036: Acknowledging Receipt

Dari: International Journal of Agronomy (sahl.abdelrahman@hindawi.com)

Kepada: gribaldi64@yahoo.co.id

Cc: sahl.abdelrahman@hindawi.com; lelinurlaili66@gmail.com; rujito62@yahoo.com

Tanggal: Senin, 27 Maret 2017 18.13 GMT+7

Dear Dr. Gribaldi,

The Research Article titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress," by Gribaldi Gribaldi, Nurlaili Nurlaili and Rujito Agus Suwignyo has been received and assigned the number 9734036.

All authors will receive a copy of all the correspondences regarding this manuscript.

Thank you for submitting your work to International Journal of Agronomy.

Best regards,

Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com

Judul **9734036: Authors' Feedback Needed**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: lelinurlaili66@gmail.com; rujito62@yahoo.com
Tanggal: Senin, 3 April 2017 19.16.26 WIB

Dear Dr. Gribaldi,

This is regarding manuscript 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" submitted to International Journal of Agronomy. While checking your manuscript, we had comments regarding the following points:

The author list on the Manuscript Tracking System (MTS) and the PDF file is different. Please confirm the correct author list along with the authors' email addresses and affiliations in order for us to update our records on the MTS.
In the reference list of the manuscript, there are not enough references to journals. It is recommended that the reference list should reflect a diversity of resources that have contributed to the scholarly content of the paper. Please update the reference list by adding more English peer-reviewed journals.
Table 5 is not cited within the text. Please provide us with an updated PDF file after including in-text citations of all tables.

We look forward to hearing from you.

Best regards,

Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com

Bls: 9734036: Open Researcher and Contributor ID

Dari: Gribaldi Ir (gribaldi64@yahoo.co.id)

Kepada: sahl.abdelrahman@hindawi.com

Tanggal: Senin, 17 April 2017 09.26 GMT+7

Dear Mr Sahl

thankyou very much regarding your information about my manuscript. unfortunately here we have difficulties to log in into your system (ORCID) we tried so many times to input my username and password, but i still can't access the page, even we changed the password we still can't log in into the system.

So,....in this case could you please help me to activate or give me some suggestion so i can log in into orchid system? need your help soon. thank you

best regards

Gribaldi

Pada Minggu, 16 April 2017 14:15, International Journal of Agronomy <sahl.abdelrahman@hindawi.com> menulis:

Dear Dr. Gribaldi,

This is regarding your manuscript titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" in International Journal of Agronomy. Please register an ID with Open Researcher and Contributor ID (ORCID) and link it to your Manuscript Tracking System (MTS) account, as we need to include authors' ORCID IDs in the article metadata that we submit to various indexing services.

ORCID is an open, non-profit, community-based effort that has been created by a number of leading research funders, universities, and publishers to solve the name ambiguity problem in scholarly communications by creating a registry of persistent unique identifiers for individual researchers and an open and transparent linking mechanism between ORCID, other ID schemes, and research objects such as publications, grants, and patents.

In order to create an ORCID ID and link it to the MTS, please go to http://mts.hindawi.com/orcid/ where you will be asked to log in using the email address "gribaldi64@yahoo.co.id" and the password that you previously registered on the system. If you do not remember your password, you can use the following link to reset it: http://mts.hindawi.com/reset.password/8e02a05c-c2c4-4bd9-aced-2bf8ac5a4406/. You will then be directed to ORCID.org where you can create your ID.

Please make sure to use the name format that is on the MTS when creating your ORCID ID, since it is highly preferred that you use the same format in all of the systems dealing with your professional activities. However, if your name on the MTS is not currently correct, let me know the format you prefer, and I will update it accordingly.

I look forward to your cooperation.

Best regards,

Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com

Bls: 9734036: Open Researcher and Contributor ID

Dari: Gribaldi Ir (gribaldi64@yahoo.co.id)

Kepada: sahl.abdelrahman@hindawi.com

Tanggal: Selasa, 18 April 2017 21.30 GMT+7

The honorable Mr. Sahl

Hereby I send you orchid ID as you requested me for via email.

name: Gribaldi
ID orchid : gribaldi64@yahoo.co.id

I need your assistance on the reactivating of my orchid that I can access it again. Thanks

Best regards

Gribaldi

Pada Selasa, 18 April 2017 14:40, Sahl Abdurrahman <sahl.abdelrahman@hindawi.com> menulis:

Dear Dr. Gribaldi,

You need to create a new account on the ORCID. The ORCID is not one of Hindawi's websites.

ORCID is an open, non-profit, community-based effort that has been created by a number of leading research funders, universities, and publishers to solve the name ambiguity problem in scholarly communications by creating a registry of persistent unique identifiers for individual researchers and an open and transparent linking mechanism between ORCID, other ID schemes, and research objects such as publications, grants, and patents.

Please provide me with the ORCID ID once you have created it.

Best regards,

Sahl

****

Sahl Abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com
****

Re: 9734036: Articles (Gribaldi-Indonesia)

Dari: Sahl Abdurrahman (sahl.abdelrahman@hindawi.com)

Kepada: gribaldi64@yahoo.co.id

Tanggal: Selasa, 18 April 2017 14.41 GMT+7

Dear Dr. Gribaldi,

Thank you for your feedback. In order to verify the institutional email address of Dr. Ekawati Danials, I have sent a confirmation email to eka_danial20@unbara.ac.id. Please ask the author to respond from that mailbox.

Best regards,

Sahl

****

Sahl Abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com
****

--------- Forwarded message ---------
From: Gribaldi Ir <gribaldi64@yahoo.co.id>
Date: 4/17/2017 5:33:29 AM
Subject: Bls: 9734036: Articles (Gribaldi-Indonesia)
To: Sahl Abdurrahman <sahl.abdelrahman@hindawi.com>

Dear Editor,
Regarding to your previous email, here I enclose the following requirements you need related to Dr. Ekawati Danial's information:
1. Dr. Ekawati Danials' email institution: eka_danial20@unbara.ac.id
2. Author previous publication:Title: "In Vitro Shoot Regeneration of Indonesian Bananas (Musa spp.) cv. Ambon Kuning and Raja Bulu, Plantlet Acclimatizationand Field Performance" Authors: Yusnita, Ekawati Danial, and Dwi HapsoroJournal: Agrivita Volume 37 No. 1, February 2015
3. Email used in previous publication: ekadanial20@gmail.com
I look forward to hearing from you.

Pada Minggu, 16 April 2017 14:30, Sahl Abdurrahman <sahl.abdelrahman@hindawi.commenulis:

Dear Dr. Gribaldi,

The files have been uploaded to the system. The provided email address ekadanial20@gmail.com for Dr. Ekawati Danial is not linked to any of his/her previous publications. Please provide me with the following:

1. The author's personal institutional email address that his

institution/university provides to him/her.

2. A list of the author's previous publications.

3. The email address that the author has used in the previous publications.

I look forward to receiving your feedback.

Best regards,

Sahl

****

Sahl Abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com

****

On 4/5/2017 4:46:53 PM, Gribaldi Ir gribaldi64@yahoo.co.id wrote:

DearChief Editor of Hindawi

>

Regarding to youremail on April 3, 2017, thereforeI enclose through this email 1. Theoriginal authorsofmanuscript are listed according to the script 9,734,036 entitled "ModifiedApplication of Nitrogen Fertilizer to Increase Rice Variety submergence TowardStress Tolerance". Thereforewe enclose the revision of author lists (attached) 2. We also submit manuscripts 9734036 that we revised as requestedby the editor (attached)Last but not least wehope that this manuscriptwill be accepted, thank you very much for your attention Best regardsGribaldi

Judul **Your Manuscript 9734036**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Tanggal: Rabu, 19 April 2017 14.18.02 WIB

Dear Dr. Gribaldi,

This is regarding your manuscript titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" in International Journal of Agronomy. Please access the below URL to register an ORCID ID and link it to your Manuscript Tracking System (MTS) account:

http://mts.hindawi.com/orcid/

Your prompt action is appreciated.

Best regards,

Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com

Bls: Your Manuscript 9734036

Dari: Gribaldi Ir (gribaldi64@yahoo.co.id)

Kepada: sahl.abdelrahman@hindawi.com

Tanggal: Kamis, 20 April 2017 09.52 GMT+7

Dear editor,

I have successfully registered an Orcid account and already linked it to my Manuscript Tracking System of Hindawi. This is my Orcid account: 0000-0003-1553-3566

If you still have something important to inform me, please do not hesitate to contact me through my email. Thank you very much for your information.

I look forward to hearing from you.

Gribaldi

Pada Rabu, 19 April 2017 14:18, International Journal of Agronomy <sahl.abdelrahman@hindawi.com> menulis:

Dear Dr. Gribaldi,

This is regarding your manuscript titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" in International Journal of Agronomy. Please access the below URL to register an ORCID ID and link it to your Manuscript Tracking System (MTS) account:

http://mts.hindawi.com/orcid/

Your prompt action is appreciated.

Best regards,

Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com

9734036: Major Revision Required

Dari: Allen Barker (ija@hindawi.com)

Kepada: gribaldi64@yahoo.co.id

Cc: barker@pssci.umass.edu; lelinurlaili66@gmail.com; nurmaladewitjekdin@gmail.com; ekadanial20@gmail.com; firnafpubr@gmail.com; rujito62@yahoo.com

Tanggal: Senin, 8 Mei 2017 23.03 GMT+7

Dear Dr. Gribaldi,

Following the review of Research Article titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" by Gribaldi Gribaldi, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena and Rujito Agus Suwignyo, I recommend that it should be revised taking into account the changes requested by the reviewer(s). Since the requested changes are major, the revised manuscript will undergo a second round of review by the same reviewer(s). Please login to the Manuscript Tracking System to read the submitted review report(s) and submit the revised version of your manuscript no later than Monday, June 05, 2017.

The referee note that the experimental design of the research was not documented and that the statistical processing of the data reported properly. The referee suggested that the results and discussion be divided into two sections and that a clear conclusion be written in a separate section to show any novel findings from the investigation. The manuscript had many problems in English grammar, spelling, and syntax, and the referee recommended that a person well-versed in the English language be consulted. The referee noted also that more up-to-date references be cited and that the citations in the text and in the list of references cited be checked to ensure compliance.

To submit the revised version of your manuscript, please access "Author Activities" in your account and upload the PDF file of your revised manuscript. Also, please submit your replies to the comments of the reviewer(s) as an additional PDF file.

Best regards,

Allen Barker
barker@pssci.umass.edu

Hindawi

9734036.v1 (Research Article)

Title	Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress
Journal	International Journal of Agronomy
Issue	Regular
Manuscript Number	9734036 (Research Article)
Submitted On	2017-03-27
Author(s)	**Gribaldi Gribaldi**, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena, Rujito Agus Suwignyo
Editor	Allen Barker
Status	Major Revision Required

No.	Review Report
16	Read

Manuscript Versions

View Version 2
View Version 1

Hindawi

9734036.v1 Review Report

Subject appropriateness of the manuscript

The topic of this manuscript falls within the scope of International Journal of Agronomy

Recommendation

Consider after major changes

Comments for the author

This paper reports the nitrogen fertilization of rice crop under submergence stress. Different levels of flooding have been used to assess the N availability to the two rice varieties. The experimental plan is good and some interesting data, although of preliminary nature, have been reported. However, overall, the paper suffers some shortcomings, which need to be addressed before reaching a final decision.
1. The authors have used quite a few treatments and their combination but no replication details and experimental designs have been reported in the Materials and Methods section. In addition which statistical test was applied to statistically analyze the data (which appears to have not done except regression line was drawn between plant dry matter and grain yield.
2. Results and Discussion have need given as one single chapter. It should be split into separate sections followed by a conclusion section. Also there should be clear cut elucidation of mechanism of submergence tolerance wit N application
3. As of now there is hard to extract any novel findings from the experimental results. The novel aspect be emphasized upon with logical discussion and conclusions
4. There are a lot of problems with the sentences construction, grammatical and spelling errors. So the paper needs to be read by the competent in English writing
5. The references need to be thoroughly cross-checked for their in-text citation and inclusion in the list. Moreover, the reference also need to be updated as I could see just one reference from the year 2016

Subject Appropriateness of the Manuscript

The topic of this manuscript falls within the scope of International Journal of Agronomy

Recommendation

Consider after Major Changes

Comments

This paper reports the nitrogen fertilization of rice crop under submergence stress. Different levels of flooding have been used to assess the N availability to the two rice varieties. The experimental plan is good and some interesting data, although of preliminary nature, have been reported. However, overall, the paper suffers some shortcomings, which need to be addressed before reaching a final decision.

1. The authors have used quite a few treatments and their combination but no replication details and experimental designs have been reported in the Materials and Methods section. In addition which statistical test was applied to statistically analyze the data (which appears to have not done except regression line was drawn between plant dry matter and grain yield.
2. Results and Discussion have need given as one single chapter. It should be split into separate sections followed by a conclusion section. Also there should be clear cut elucidation of mechanism of submergence tolerance wit N application
3. As of now there is hard to extract any novel findings from the experimental results. The novel aspect be emphasized upon with logical discussion and conclusions
4. There are a lot of problems with the sentences construction, grammatical and spelling errors. So the paper needs to be read by the competent in English writing
5. The references need to be thoroughly cross-checked for their in-text citation and inclusion in the list. Moreover, the reference also need to be updated as I could see just one reference from the year 2016

Hindawi
International Journal of Agronomy
Article ID 9734036

Research Article

Modified Application of Nitrogen Fertilizer for Increasing Rice Variety Tolerance toward Submergence Stress

Gribaldi Gribaldi,[1] Nurlaili Nurlaili,[1] Nurmala Dewi,[1] Ekawati Danial,[1] Firnawati Sakalena,[1] and Rujito A. Suwignyo[2]

[1] *Faculty of Agriculture, University of Baturaja, Jl. Ratu Penghulu No. 02301, Karang Sari, Baturaja, South Sumatra 32115, Indonesia*
[2] *Faculty of Agriculture, Sriwijaya University, Jl. Palembang-Prabumulih KM 32, Ogan Ilir, South Sumatra, Indonesia*

Correspondence should be addressed to Gribaldi Gribaldi; gribaldi64@yahoo.co.id

Received 27 March 2017; Revised 2 June 2017; Accepted 4 June 2017

Academic Editor: Allen Barker

This research was conducted from July to October 2015, using Randomized Block Design with two treatment factors and three replications for each treatment. The first factor was rice varieties (V): V1 = IR 64; V2 = Inpara 5. The second factor was fertilizer (N): N0: without submergence, all N fertilizer was given during planting; N1: all N fertilizer dose was given during planting; and N2: 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Submergence during 7–14 days after planting; N3 = All N fertilizer dose was given during planting, N4 = 1/2 dose of N fertilizer was given during planting, and the rest was given at 42 days after planting. The submergence was during 7–14 and 28–35 days after planting. The results showed that the management of nitrogen fertilizer application had effect on rice growth and production which experienced dirty water submergence stress; the application of 1/2 dose of N fertilizer given during planting (and the rest was given at 42 days after planting) had the best effect on rice growth and production; the longer the submergence period for rice variety, the higher the effect on rice growth and production.

1

1. Introduction

2 Food crop production, especially rice (*Oryza sativa* L.), should be increased in annual basis according to the increase of population growth. The increase of production can be done through productivity improvement at submergence stress prone areas which is considered as the main constraint in rice crop cultivation. The area of rice production centers which are mostly located in lowland areas would be extremely vulnerable to the growing possibility of flooding [1]. According to [2], submergence that causes stress on rice crop at South Asia and Southeast Asia areas was estimated of about 15 million hectares per year, whereas flood-prone rice field areas at South Sumatra were 124,465 ha [3].

Submergence stress on crop causes the obstacle of crop growth and production. Estimated yield loss due to flood was about 1.1 million tons of unhulled rice per year or equivalent to yield loss of 0.66 million tons of hulled rice [4]. In addition, [5] showed that rice crop which experienced submergence stress can decrease its grain yield with magnitude of 17.5% compared to the rice crop without submergence stress. One solution to overcome this problem is through development of high yield rice varieties that are tolerant to submergence stress.

Rice productivity in areas planted in this way is low and unstable, averaging $< 2.0\,t\,ha^{-1}$ in rainfed lowlands and $<1.5\,t\,ha^{-1}$ in flood-prone areas, compared with yields of $>5.0\,t\,ha^{-1}$ in input-intensive irrigated systems [6, 7]. This results in serious crop losses and sometimes leads to severe food shortages in flood-affected regions [8]. 3

Rice variety of IR 64 was developed by IRRI in 2006 which was subsequently converted into IR 64 *Sub-1* (Inpara 5) variety by transferring *Sub-1* gene from FR13A species which is tolerant to submergence condition. This variety is able to decrease harvest loss risk during wet season due to unpredictable change of climate [2].

The decrease of unhulled rice yield due to the submergence for rice variety containing Sub-1 gene was lower than

Table 1: Analysis results of soil properties before treatment.

Analyses	Unit	Result	Status
pH H_2O		4.03	Very acidic
C-organic	%	1.82	Low
N-total	%	0.17	Low
P-Bray I	ppm	13.65	Low
K-dd	me·100 g^{-1}	0.26	Low
Na	me·100 g^{-1}	0.22	Low
Ca	me·100 g^{-1}	1.30	Very low
Mg	me·100 g^{-1}	0.25	Very low
CEC	me·100 g^{-1}	13.08	Low
Al-dd	me·100 g^{-1}	1.00	Very low

Source: Soil Science Laboratory, Faculty of Agriculture, Unsri, 2015.

Table 2: Percentage of survive plant (%) of two rice varieties and fertilizing treatment in condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR 64	100.0^{b}	100.0^{b}	100.0^{b}	66.7^{a}	83.3^{ab}
Inpara 5	100.0^{b}	100.0^{b}	100.0^{b}	100.0^{b}	100.0^{b}

Notes. N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: with submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant difference or $LSD_{0.05}$: 26.4.

the rice variety which does not contain Sub-1 gene. The yield decrease on IR 64 rice variety *Sub-1* was 16 percent, whereas IR 64 rice variety without *Sub-1* gen was 39 percent [9]. According to [4], rice yield loss was about 30 percent due to the submergence condition and if this loss can be reduced to less than 10 percent through agronomical treatment, then it has high significant contribution for farmers and increment of national rice production.

In addition to the use of tolerant rice variety to submergence stress, proper fertilizing technique also can minimize the decrease of rice yield due to the submergence condition. Fertilizing treatment before crop was submerged might maintain crop survival at submergence condition. According to [10], N fertilizing might be a proper measure to minimize negative impact from submergence stress on crop. Management treatment of nitrogen fertilizer application will give significant effect on crop height and height increment rate of rice crop. These two parameters on rice crop usually will be more affected with submergence condition of more than three days [11]. The stem length increment rate during occurrence of submergence stress had significant effect on rice crop tolerance and crop recovery rate after submergence stress [12, 13]. Moreover, study results by [14] showed that rice varieties given half dose of Urea during planting period added to (Si + Zn) fertilizer tend to show better vegetative and
4 generative growths.
5

Table 3: Plant height (cm) at 42 days after planting of two rice varieties and fertilizing treatment at condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR64	107.0^{ab}	104.2^{ab}	108.3^{b}	85.2^{a}	99.3^{ab}
Inpara 5	109.1^{ab}	103.5^{ab}	107.5^{ab}	90.7^{ab}	101.0^{ab}

Notes. N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: for submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant difference or $LSD_{0.05}$: 22.8.

Table 4: Productive tiller numbers of two rice varieties and fertilizing treatment at condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR64	26.0^{c}	25.2^{bc}	25.7^{c}	13.2^{a}	15.8^{a}
Inpara 5	27.7^{c}	26.7^{c}	30.8^{c}	16.7^{a}	18.7^{ab}

Notes. N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: with submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant Difference or $LSD_{0.05}$: 7.0.

Table 5: The fertilizing effect for two rice varieties on several yield components at condition of dirty water submergence stress

Treatment	Inpara 5			IR64		
	1	2	3	1	2	3
N0	130.8	93.0	2.39	128.5	91.0	2.49
N1	123.2	90.1	2.37	118.7	91.7	2.38
N2	128.9	93.2	2.36	129.7	92.6	2.42
N3	101.3	89.5	2.32	110.8	89.2	2.37
N4	112.3	91.8	2.44	122.1	91.1	2.41

Remarks: 1: the number of grains per panicle (grains), 2: percentage of grain pithy (%), 3: grain weight of 100 grains (g). N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: with submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

The research objective was to determine the best fertilization that can increase rice crop tolerance toward submergence stress.

2. Materials and Methods

2.1. Experiment Site. This research was conducted from July to October 2015 at Experimental Plot of Agricultural Faculty, Baturaja University. Research station is situated at altitude 13 m above mean sea level.

2.2. Experiment Design. The experimental design used in this research was Randomized Block Design with two treatment factors and three replications for each treatment as well as one crop clump for each treatment unit. The first factor was rice varieties (V) consisting of V1 = IR 64 and V2 = Inpara 5. The second factor was fertilizer (N) treatments consisting of N0 = without submergence: that is, all N fertilizer was given during planting; N1: for submergence during 7–14 days after planting (DAP), N fertilizer was given during planting; N2: for submergence during 7–14 DAP, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 DAP; N3: for submergence during 7–14 and 28–35 DAP, all N fertilizer dose was given during planting; N4: for submergence during 7–14 and 28–35 DAP, 1/2 dose of N fertilizer was given during 6 planting and the rest was given at 42 DAP.

2.3. Implementation of Field Research. Rice variety seeds were incubated for 3 days and after germination period they were put into plastic trays media with dimension of 40 cm in length, 30 cm in width, and 13 cm in depth. These trays previously were filled with 15 kg of lowland swamp soil treated with fertilizers of N, P, K, Si, and Zn as well as manure at doses of 60, 40, 40, 30, and 20 $kg{\cdot}ha^{-1}$ as well as 10 $ton{\cdot}ha^{-1}$, respectively [15]. Seeds of 21 days old within seedling trays were pulled out and planted in polybag plastic with one rice crop seed per polybag containing 10 kg of lowland swamp soil that had previously been submerged for about 30 days. These planting media were added to fertilizers as follows: full dose of N = 46 $kg{\cdot}ha^{-1}$, half dose of N = 23 $kg{\cdot}ha^{-1}$, SP 36 = 128 $kg{\cdot}ha^{-1}$, and KCl = 100 $kg{\cdot}ha^{-1}$. These fertilizers were submerged into soil at depth of 10 cm. Submergence was done by putting rice crops into tray that had been filled with dirty water (equivalent to 500 g soil/100 l water) with submergence period of 7 days. Minimum water submergence was 15 cm above plant surface. Rearing was in form of maintaining water submergence height during treatment period.

2.4. Yield and Observation. Observation of agronomical characteristics consisted of percentage of surviving 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 consisted of number of grains per panicle, 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. When ANOVA indicated a significant *F*-value, multiple comparisons of mean values were performed by the least significant difference test at $\alpha = 0.05$. Relationship between variables observations is sought by correlation. Data were processed using SAS program Portable 9.1.3 for the *F* test and SPSS 19 for correlation.

3. Results

3.1. Soil Chemical Properties Prior to Treatment. Analysis results of soil chemical properties prior to treatment (Table 2) showed that soil used in this research were lowland swamp soil with very acid reaction, low C-organic content, and low total-N content. Low availability of phosphorus nutrient and low K-dd in this soil showed that effort of fertilizer application could overcome low nutrients availability and could increase rice crop yield.

3.2. Percentage of Survive Plant. Percentage of live crops decreased in IR 64 varieties which experienced two times soaking (N3, N4) compared with one time soaking (N1, N2) (Table 2). While Inpara 5 varieties have a high percentage of live plants (100%) despite having two times soaking. Percentage of live crops in treatment of IR 64 varieties treated with full N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest live plant percentage, which was 66.7 percent.

3.3. Plant Height. With the stress of the soaking effects on plant height at 42 hst observation, plant height of rice varieties having two times soaking periods (N3, N4) decreased compared to one time immersion (N1, N2) (Table 3). Plant 7 height of two rice varieties in the same immersion conditions was not significant for each fertilizer treatment but tended to differ significantly between the immersion treatments. Treatment of IR 64 varieties given full dose N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest plant height of 85.2 cm and the highest in treatment of IR 64 varieties which were given 1/2 dose N fertilizer at planting time , and the rest was administered at 42 hst 8 with 7–14 hst immersion (V1N2), which was 108.3 cm, and the plant height in this treatment showed no significant difference with nonimmersion treatment (V1N0).

3.4. Number of Productive Tillers. The number of productive tillers decreased in the rice varieties with two times immersion (N3, N4) compared to one time immersion (N1, N2) (Table 3). Two rice varieties experiencing the same immersion conditions resulted in a number of no significant difference productive tillers for each fertilization treatment, but significantly different for the immersion treatment. Treatment of IR 64 varieties given full dose of N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest number of productive tillers, that is, 13.2 tillers, the highest number of tillers in the treatment of Inpara 5 was given 1/2 dose N fertilizer at planting time, and the rest was given at 42 hst with immersion of 7–14 hst (V2N2), which was 30.8 tillers; besides, the number of productive tillers in this treatment showed no significant difference with treatment without immersion (V2N0).

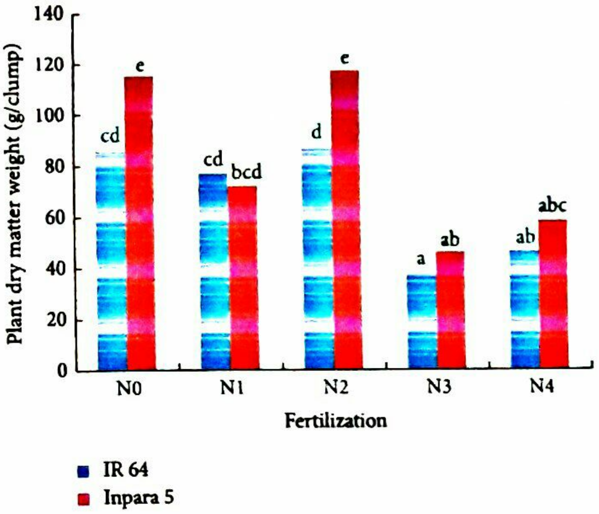


Figure 1: Plant dry matter weight at the end of research for two rice varieties and fertilizing treatment at condition of dirty water submergence stress. N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3, with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: with submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant difference or $LSD_{0.05}$: 27.9.

3.5. Plant Dry Matter Weight. Plant dry matter weight was decreased in rice varieties with two times immersion (N3, N4) compared to one immersion (N1, N2) (Figure 1). Two rice varieties experiencing the same immersion conditions resulting in different dry weight of plants were not significant for each fertilization treatment but differed significantly for immersion treatment. Treatment of IR 64 varieties given full dose N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest dry weight plant, that is, 37.5 g/clump, and highest dry weight in treatment Inpara 5 which was given 1/2 fertilizer dose N at planting time, and the rest was administered at 42 hst with immersion of 7–14 hst (V1N2), which was 117,5 g/clump; besides, the amount of dry weight of plant in this treatment showed no significant difference with nonimmersion treatment (V2N0).

3.6. Yield and Yield Components. Arrangement of nitrogen fertilizer supply affects the yield and component of grain yield per clump. Results and components of grain yield per clump were decreased in rice varieties with two times immersion (N3, N4) compared to one immersion (N1, N2) (Figure 2 and Table 5). Treatment of IR 64 varieties given full dose N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest grain yield, that is, 58.3 g/clump and highest grain yield on treatment Inpara 5 which was given 1/2 dose N fertilizer at planting time, and the rest was given at 42 hst with immersion of 7–14 hst (V1N2), which was 88.6 g/clump; besides, the grain yield on this treatment also showed different not significant with nonimmersion treatment (V2N0). 9

Furthermore, there is a very strong relationship pattern between grain yield per clump with dry weight of plant per clump, with the equation $Y = 55{,}137 + 0{,}259X$: $R2 = 0{,}817^{*}$ (Figure 2). The higher the dry weight of the plant, the higher the yield of grain obtained. 10

4. Discussion

Analysis results of soil chemical properties prior to treatment (Table 1) showed that soil used in this research was lowland swamp soil with very acid reaction, low C-organic content, and low total-N content. Low availability of phosphorus nutrient and low K-dd in this soil showed that effort of fertilizer application could overcome low nutrients availability and could increase rice crop yield.

The immersion stress has an effect on the tolerance, growth, and yield of grain per clump of rice plants, as seen from the changes of life plant percentage, plant height, number of productive tillers, dry weight of plant and yield also some component of yield. 11

Crop tolerance is the ability of plants to avoid or reduce damage to crops with the presence of soaking stress so as to grow and produce as in plants that do not experience the immersion stress. The longer and more frequent the rice plants experience soaking stress, the greater the damage that occurs in plants. The regulation of N fertilizer application statistically was not significant but it showed a tendency of increasing the percentage of live plants by 16.6 percent. According to [10], N fertilizer application was the proper measure to decrease negative effect of submergence stress on crop. Moreover, according to [16], recovery capacity highly depends on plant capability to adapt quickly to certain condition after they experience flooding stress. In addition, [4] stated that better recovery for rice plant which experienced submergence stress was indicated by faster new tillers emergence so that plant had relatively same tiller numbers or even higher tiller numbers than that of plant which did not experience submergence stress.

Management of N fertilizer application had effect on rice plant height. Rice variety which was treated with half dose of N fertilizer during planting time (and the rest was given at 42 days after planting) either received one time submergence or two times submergence and tends to have higher plant height than that of other fertilizing treatments. IR 64 rice variety even with one time submergence had higher plant height than without submergence treatment with magnitude of 107.5 cm. According to [11], management of N fertilizer application had effect on plant height and increment rate of plant height. In addition, [12] stated that plant height after flooding stress period was more affected by rice variety than by fertilization treatment. The papers [17–19] also stated that the increase in plant height becomes more noticeable with prolonged submergence.

Rice varieties which experienced submergence stress treated with half dose of N fertilizer during planting time

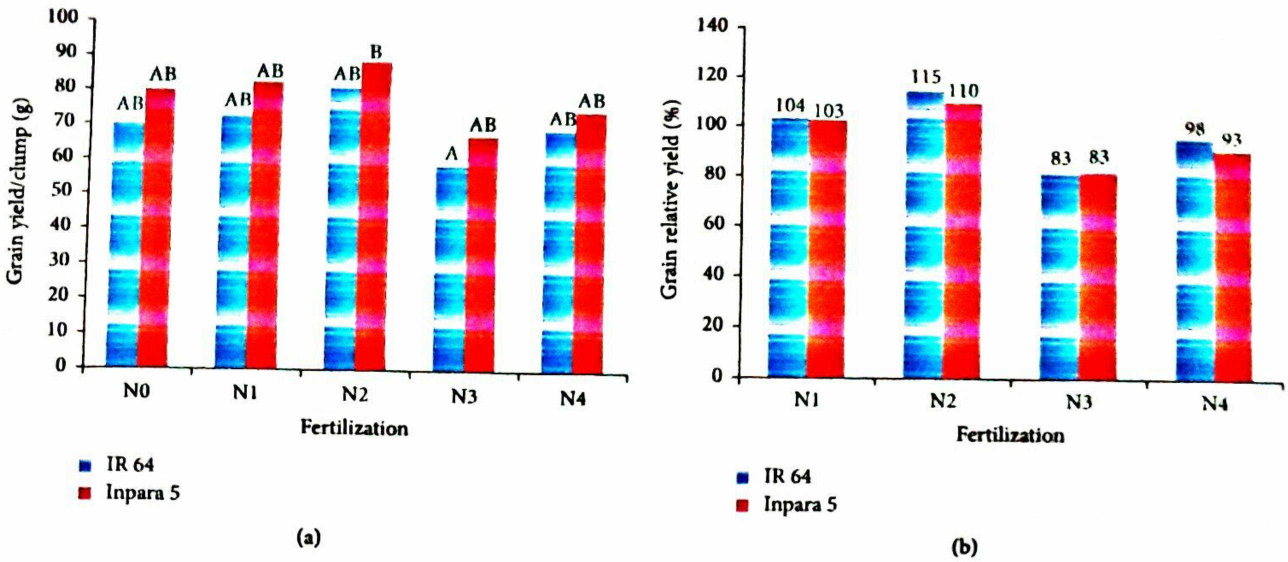


FIGURE 2: Fertilizing treatment effect for two rice varieties on grain yield (a) and relative grain yield (b) at condition of dirty water submergence stress. N0: without submergence, all N fertilizer was given during planting; N1: for submergence during 7–14 days after planting, N fertilizer was given during planting; N2: for submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: for submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: for submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant difference or $LSD_{0.05}$: 28.7.

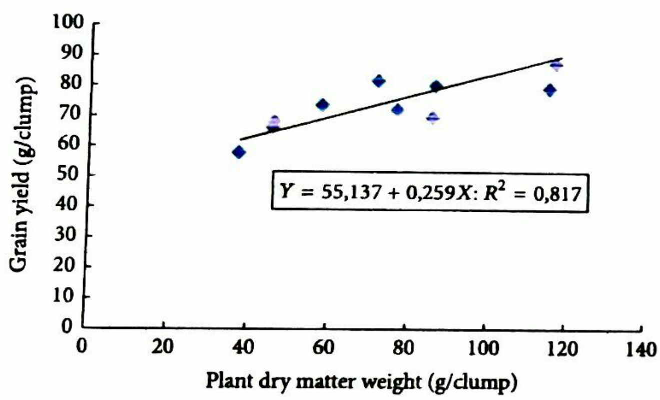


FIGURE 3: Relationship pattern between plant dry matter weight and grain yield.

(and the rest was given at 42 days after planting) tend to have higher plant dry matter weight than that of other fertilizing treatments; even IR 64 and Inpara 5 varieties which experienced one time submergence tend to have higher plant dry matter weight than that of without submergence with magnitude of 86.7 g and 117.2 g, respectively. This was due to the fact that varieties treated with this fertilizer had higher plant height and higher tiller numbers than the other fertilizing treatments so that dry matter weight of these varieties was also high. According to [20], the weight increasing of plant dry is an indicator of growth and development of increasing plant. In addition, [21] stated that postsubmergence stem dry weight correlated positively and strongly with survival (r = 0,97).

Inpara 5 variety treated with half dose of N fertilizer during planting time (and the rest was given at 42 days after planting) showed higher grain yield than that of other treatments, either for one time submergence or for two times submergence with grain yield of 88.6 g and 73.4 g, respectively. This was in accordance with high change of plant dry matter weight in this treatment resulting in high capability of plant to distribute assimilates into generative organ so that stem can produce more full grain which was shown by the change of several yield components on this treatment (Table 6). Study results from [22] showed that 12
fertilization with half dose of Urea fertilizer during planting as well as Si and Zn in which the remainder was applied at 42 days after planting had produced the highest grain yield for all tested varieties for flooding period of 7 to 14 days after planting.

Moreover, there was very close relationship pattern between grain yield per clump and plants dry matter weight per clump expressed by equation of $Y = 55.137 + 0.259X$: $R^2 = 0.817^{*}$ (Figure 3). The higher the plants dry matter weight, the higher the obtained grain yield. In addition, the research result of [23] reported that the grain yield also has very real relationship to the nitrogen content ($r > 0.73^{**}$).

5. Conclusions

The results showed that management of nitrogen fertilizer application had effect on rice growth and production which experienced dirty water submergence stress. Application of half dose of N fertilizer during planting time (and the rest was given at 42 days after planting) was the best treatment in terms of rice growth and production. The longer the 14 submergence period on rice variety, the bigger the effect on rice growth and production.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors especially wish to acknowledge the Ministry of Research, Technology and Higher Education that had already provided funding for this research through Competitive Research Grant (*Hibah Bersaing*) for fiscal year of 2015.

References

[1] C. Aydinalpn and M. S. Cresser, "The effect of global climate
13 change on agriculture," *American-Eurasian J. Agric. Environ. Sci*, vol. 3, pp. 672–676, 2008.

[2] E. M. Septiningsih, A. M. Pamplona, D. L. Sanchez et al., "Development of submergence-tolerant rice cultivars: the Sub1 locus and beyond," *Annals of Botany*, vol. 103, no. 2, pp. 151–160, 2009.

[3] Badan Perencanaan Pembangunan Nasional, "Indonesia Climate Change Sectoral Roadmap (ICCSR) of agrcultural sector," 2010, http://bappenas.go.id.

[4] A. K. Makarim, E. Suhartatik, G. R. Pratiwi, and Ikhwani, "Assembly of rice production technology on swamp land and flooding prone swamp (>15 days) for minimum productivity of 7 t ha^{-1}," A Final Report of ROPP DIPA, Indonesian Rice Research Institute. Indonesian Agricultural Research and Development, 2009.

[5] Ikhwani, "Resistency of submergence tolerant rice variety and its response to fertilizers," *Jurnal Lahan Suboptimal*, vol. 2, no. 1, pp. 1–13, 2013.

[6] A. M. Ismail, U. S. Singh, S. Singh, M. H. Dar, and D. J. Mackill, "The contribution of submergence-tolerant (Sub1) rice varieties to food security in flood-prone rainfed lowland areas in Asia," *Field Crops Research*, vol. 152, pp. 83–93, 2013.

[7] U. S. Singh, M. H. Dar, S. Singh et al., "Field performance, dissemination, impact and tracking of submergence tolerant (Sub1) rice varieties in South Asia," *Sabrao Journal of Breeding and Genetics*, vol. 45, no. 1, pp. 112–131, 2013.

[8] D. J. Mackill, A. M. Ismail, U. S. Singh, R. V. Labios, and T. R. Paris, "Development and rapid adoption of submergence-tolerant (Sub1) rice varieties," *Advances in Agronomy*, vol. 115, pp. 299–352, 2012.

[9] IRRI and The Research and Development Council of Food Crops, *Submergence Tolerant Rice*, Food Crops Research and Development Center, 2009.

[10] S. T. Reed and G. G. Gordon, "Nitrogen fertilization effects on recovery of bush beans from flooding," *International Journal of Vegetable Science*, vol. 14, no. 3, pp. 256–272, 2008.

[11] R. A. Suwignyo, F. Zulvica, and Hendryansyah, "Technological adaptation for rice production at lowland swamp area: the effort to prevent the negative effect of rice crop flooding through regulation of nitrogen fertilizer application," in *Proceedings of the 3rd National Seminar on Rice Day*, Indonesian Rice Research Institute, Sukamandi, Indonesia, July 2008.

[12] " The effect of fertilization on morphophysiological changes of two rice varieties under submergence stress," *Jurnal Agronomi Indonesia*, vol. 42, no. 1, pp. 17–23, 2014.

[13] R. A. Suwignyo, F. Zulvica, and L. Hakim, "The response of several rice varieties to nitrogen treatment in seedling and silica application through coal ash residue," in *Proceedings of the 3rd National Seminar on Rice Day*, Indonesian Rice Research Institute, Sukamandi, Indonesia, July 2008.

[14] R. A. Gribaldi, M. Suwignyo, R. Hasmeda, and R. Hayati, "The arrangement of nitrogen fertilizer application to increase the rice plant tolerance and recovery to the submerged stress," *Jurnal Lahan Suboptimal*, vol. 2, no. 2, pp. 151–158, 2013.

[15] R. A. Suwignyo, A. Wijaya, H. Sihombing, and G. Gribaldi, "Modification of nutrients application to improve rice seeds vigor in submergence condition," *Jurnal Lahan Suboptimal*, vol. 1, no. 1, pp. 1–11, 2012.

[16] Gribaldi, R. A. Suwignyo, M. Hasmeda, and R. Hayati, "Fertilization strategy to increase rice growth and production under two flooding condition on two lowland swamp types," *Agrivita*, vol. 38, no. 1, pp. 64–72, 2016.

[17] A. Anandan, G. Rajiv, A. Ramarao, and M. Prakash, "Internode elongation pattern and differential response of rice genotypes to varying levels of flood water," *Functional Plant Biology*, vol. 39, no. 2, pp. 137–145, 2012.

[18] B. Wang, Y. J. Zhou, Y. Z. Xu, G. Chen, Q. F. Hu, and W. G. Wu, "Effect effects of waterlogging stress on growth and yield of middle season rice at the tillering stage," *China Rice*, vol. 20, pp. 68–75, 2014.

[19] M. B. Jackson, "Ethylene-promoted elongation: an adaptation to submergence stress," *Annals of Botany*, vol. 101, no. 2, pp. 229–248, 2008.

[20] E. Mungara, D. Indradewa, and R. Rogomulyo, "Analysis of growth and rice yields (Oryza sativa L.) conventional, organic transitional and organic farming system," *Jurnal Vegetalika*, vol. 2, no. 3, pp. 1–12, 2013.

[21] S. Singh, D. J. Mackill, and A. M. Ismail, "Physiological basis of tolerance to complete submergence in rice involves genetic factors in addition to the SUB1 gene," *AoB PLANTS*, vol. 6, Article ID plu060, 2014.

[22] Gribaldi, *Agronomical treatment to increase rice crop's tenacity and recovery toward submergence stress [Ph.D. thesis]*, Faculty of Agriculture, Sriwijaya University, Palembang, Indonesia, 2013.

[23] Y. Zhang, Z. Wang, L. Li et al., "Short-term complete submergence of rice at the tillering stage increases yield," *PLoS ONE*, vol. 10, no. 5, Article ID e0127982, 2015.

Composition Comments

1. Please check and confirm the author(s) first and last names and their order which exist in the last page.

2. The highlighted part in the abstract is grammatically unclear/incorrect. Please rephrase this part for the sake of clarity and correctness.

3. Please refer to Table 4 in text as per journal style.

4. There is a difference between the manuscript and the electronic version in Figure 3 and we followed the electronic version. Please check.

5. We removed the extra "/" after the label "R^2 = 0,817" in Figure 3. Please check.

6. The highlighted part was modified for the sake of clarity. Please check.

7. The highlighted part was modified for the sake of clarity. Please check.

8. The highlighted part is grammatically unclear/incorrect. Please rephrase this part for the sake of clarity and correctness.

9. The highlighted part is grammatically unclear/incorrect. Please rephrase this part for the sake of clarity and correctness.

10. Please specify what "*, **" refer to in the highlighted parts.

11. The highlighted part is grammatically unclear/incorrect. Please rephrase this part for the sake of clarity and correctness.

12. Please specify what the highlighted part refer to as it does not exist in the paper.

13. Comment on ref. [1]: Please provide the full name of this journal, if possible.

14. Comment on ref. [12]: Please provide all the names of the author(s) for this reference.

Author(s) Name(s)

It is very important to confirm the author(s) last and first names in order to be displayed correctly on our website as well as in the indexing databases:

Author 1
Given Names: Gribaldi
Last Name: Gribaldi

Author 2
Given Names: Nurlaili
Last Name: Nurlaili

Author 3
Given Names: Nurmala
Last Name: Dewi

Author 4
Given Names: Ekawati
Last Name: Danial

Author 5
Given Names: Firnawati
Last Name: Sakalena

Author 6
Given Names: Rujito A.
Last Name: Suwignyo

It is also very important for each author to provide an ORCID (Open Researcher and Contributor ID). ORCID aims to solve the name ambiguity problem in scholarly communications by creating a registry of persistent unique identifiers for individual researchers.

To register an ORCID, please go to the Account Update page (http://mts.hindawi.com/update/) in our Manuscript Tracking System and after you have logged in click on the ORCID link at the top of the page. This link will take you to the ORCID website where you will be able to create an account for yourself. Once you have done so, your new ORCID will be saved in our Manuscript Tracking System automatically.

Judul **9734036: Revised Version Received**

Dari: sahl.abdelrahman@hindawi.com

Kepada: gribaldi64@yahoo.co.id

Cc: sahl.abdelrahman@hindawi.com; lelinurlaili66@gmail.com; nurmaladewitjekdin@gmail.com; ekadanial20@gmail.com; firnafpubr@gmail.com; rujito62@yahoo.com

Tanggal: Jumat, 2 Juni 2017 23.11.20 WIB

Dear Dr. Gribaldi,

The revised version of Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" by Gribaldi Gribaldi, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena and Rujito Agus Suwignyo has been received. The editor assigned to handle the review process of your manuscript will inform you as soon as a decision is reached.

Thank you for submitting your work to International Journal of Agronomy.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com
****
Celebrating our 20th Anniversary

Hindawi

9734036.v2 (Research Article)

Title	Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress
Journal	International Journal of Agronomy
Issue	Regular
Additional Files	Reply to review reports
Manuscript Number	9734036 (Research Article)
Resubmitted On	2017-06-02
Author(s)	**Gribaldi Gribaldi**, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena, Rujito Agus Suwignyo
Editor	Allen Barker
Status	Published

No.	Review Report
16	Read

Manuscript History

View Version 1

Hindawi
International Journal of Agronomy
Article ID 9734036

Research Article

Modified Application of Nitrogen Fertilizer for Increasing Rice Variety Tolerance toward Submergence Stress

Gribaldi Gribaldi,[1] Nurlaili Nurlaili,[1] Nurmala Dewi,[1] Ekawati Danial,[1] Firnawati Sakalena,[1] and Rujito A. Suwignyo[2]

[1]*Faculty of Agriculture, University of Baturaja, Jl. Ratu Penghulu No. 02301, Karang Sari, Baturaja, South Sumatra 32115, Indonesia*
[2]*Faculty of Agriculture, Sriwijaya University, Jl. Palembang-Prabumulih KM 32, Ogan Ilir, South Sumatra, Indonesia*

Correspondence should be addressed to Gribaldi Gribaldi; gribaldi64@yahoo.co.id

Received 27 March 2017; Revised 2 June 2017; Accepted 4 June 2017

Academic Editor: Allen Barker

This research was conducted from July to October 2015, using Randomized Block Design with two treatment factors and three replications for each treatment. The first factor was rice varieties (V): V1 = IR 64; V2 = Inpara 5. The second factor was fertilizer (N): N0: without submergence, all N fertilizer was given during planting; N1: all N fertilizer dose was given during planting; and N2: 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. The submergence was during 7–14 days after planting; N3 = the entire dose of N fertilizer that was given during planting, N4 = 1/2 the dose of N fertilizer that was given during planting, and the rest was given at 42 days after planting. The submergence was during 7–14 and 28–35 days after planting. The results showed that the management of nitrogen fertilizer application had effect on rice growth and production which experienced dirty water submergence stress; the application of 1/2 dose of N fertilizer given during planting (and the rest was given at 42 days after planting) had the best effect on rice growth and production; the longer the submergence period for rice variety, the higher the effect on rice growth and production.

1. Introduction

Food crop production, especially rice (*Oryza sativa* L.), should be increased in annual basis according to the increase of population growth. The increase of production can be done through productivity improvement at submergence stress prone areas which is considered as the main constraint in rice crop cultivation. The area of rice production centers which are mostly located in lowland areas would be extremely vulnerable to the growing possibility of flooding [1]. According to [2], submergence that causes stress on rice crop at South Asia and Southeast Asia areas was estimated of about 15 million hectares per year, whereas flood-prone rice field areas at South Sumatra were 124,465 ha [3].

Submergence stress on crop causes the obstacle of crop growth and production. Estimated yield loss due to flood was about 1.1 million tons of unhulled rice per year or equivalent to yield loss of 0.66 million tons of hulled rice [4]. In addition, [5] showed that rice crop which experienced submergence stress can decrease its grain yield with magnitude of 17.5% compared to the rice crop without submergence stress. One solution to overcome this problem is through development of high yield rice varieties that are tolerant to submergence stress.

As shown in Table 4, rice productivity in areas planted in this way is low and unstable, averaging < 2.0 t ha^{-1} in rainfed lowlands and <1.5 t ha^{-1} in flood-prone areas, compared with yields of >5.0 t ha^{-1} in input-intensive irrigated systems [6, 7]. This results in serious crop losses and sometimes leads to severe food shortages in flood-affected regions [8].

Rice variety of IR 64 was developed by IRRI in 2006 which was subsequently converted into IR 64 *Sub-1* (Inpara 5) variety by transferring *Sub-1* gene from FR13A species which is tolerant to submergence condition. This variety is able to decrease harvest loss risk during wet season due to unpredictable change of climate [2].

The decrease of unhulled rice yield due to the submergence for rice variety containing Sub-1 gene was lower than

Table 1: Analysis results of soil properties before treatment.

Analyses	Unit	Result	Status
pH H_2O		4.03	Very acidic
C-organic	%	1.82	Low
N-total	%	0.17	Low
P-Bray I	ppm	13.65	Low
K-dd	me·100 g^{-1}	0.26	Low
Na	me·100 g^{-1}	0.22	Low
Ca	me·100 g^{-1}	1.30	Very low
Mg	me·100 g^{-1}	0.25	Very low
CEC	me·100 g^{-1}	13.08	Low
Al-dd	me·100 g^{-1}	1.00	Very low

Source: Soil Science Laboratory, Faculty of Agriculture, Unsri, 2015.

Table 2: Percentage of survive plant (%) of two rice varieties and fertilizing treatment in condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR 64	100.0^{b}	100.0^{b}	100.0^{b}	66.7^{a}	83.3^{ab}
Inpara 5	100.0^{b}	100.0^{b}	100.0^{b}	100.0^{b}	100.0^{b}

Notes. N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: with submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant difference or $LSD_{0.05}$: 26.4.

Table 3: Plant height (cm) at 42 days after planting of two rice varieties and fertilizing treatment at condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR64	107.0^{ab}	104.2^{ab}	108.3^{b}	85.2^{a}	99.3^{ab}
Inpara 5	109.1^{ab}	103.5^{ab}	107.5^{ab}	90.7^{ab}	101.0^{ab}

Notes. N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: for submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant difference or $LSD_{0.05}$: 22.8.

Table 4: Productive tiller numbers of two rice varieties and fertilizing treatment at condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR64	26.0^{c}	25.2^{bc}	25.7^{c}	13.2^{a}	15.8^{a}
Inpara 5	27.7^{c}	26.7^{c}	30.8^{c}	16.7^{a}	18.7^{ab}

Notes. N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: with submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant Difference or $LSD_{0.05}$: 7.0.

Table 5: The fertilizing effect for two rice varieties on several yield components at condition of dirty water submergence stress

Treatment	Inpara 5			IR64		
	1	2	3	1	2	3
N0	130.8	93.0	2.39	128.5	91.0	2.49
N1	123.2	90.1	2.37	118.7	91.7	2.38
N2	128.9	93.2	2.36	129.7	92.6	2.42
N3	101.3	89.5	2.32	110.8	89.2	2.37
N4	112.3	91.8	2.44	122.1	91.1	2.41

Remarks: 1: the number of grains per panicle (grains), 2: percentage of grain pithy (%), 3: grain weight of 100 grains (g). N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: with submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

the rice variety which does not contain Sub-1 gene. The yield decrease on IR 64 rice variety *Sub-1* was 16 percent, whereas IR 64 rice variety without *Sub-1* gen was 39 percent [9]. According to [4], rice yield loss was about 30 percent due to the submergence condition and if this loss can be reduced to less than 10 percent through agronomical treatment, then it has high significant contribution for farmers and increment of national rice production.

In addition to the use of tolerant rice variety to submergence stress, proper fertilizing technique also can minimize the decrease of rice yield due to the submergence condition. Fertilizing treatment before crop was submerged might maintain crop survival at submergence condition. According to [10], N fertilizing might be a proper measure to minimize negative impact from submergence stress on crop. Management treatment of nitrogen fertilizer application will give significant effect on crop height and height increment rate of rice crop. These two parameters on rice crop usually will be more affected with submergence condition of more than three days [11]. The stem length increment rate during occurrence of submergence stress had significant effect on rice crop tolerance and crop recovery rate after submergence stress [12, 13]. Moreover, study results by [14] showed that rice varieties given half dose of Urea during planting period added to (Si + Zn) fertilizer tend to show better vegetative and generative growths.

The research objective was to determine the best fertilization that can increase rice crop tolerance toward submergence stress.

2. Materials and Methods

2.1. Experiment Site. This research was conducted from July to October 2015 at Experimental Plot of Agricultural Faculty, Baturaja University. Research station is situated at altitude 13 m above mean sea level.

2.2. Experiment Design. The experimental design used in this research was Randomized Block Design with two treatment factors and three replications for each treatment as well as one crop clump for each treatment unit. The first factor was rice varieties (V) consisting of V1 = IR 64 and V2 = Inpara 5. The second factor was fertilizer (N) treatments consisting of N0 = without submergence: that is, all N fertilizer was given during planting; N1: for submergence during 7–14 days after planting (DAP), N fertilizer was given during planting; N2: for submergence during 7–14 DAP, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 DAP; N3: for submergence during 7–14 and 28–35 DAP, all N fertilizer dose was given during planting; N4: for submergence during 7–14 and 28–35 DAP, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 DAP.

2.3. Implementation of Field Research. Rice variety seeds were incubated for 3 days and after germination period they were put into plastic trays media with dimension of 40 cm in length, 30 cm in width, and 13 cm in depth. These trays previously were filled with 15 kg of lowland swamp soil treated with fertilizers of N, P, K, Si, and Zn as well as manure at doses of 60, 40, 40, 30, and 20 $kg{\cdot}ha^{-1}$ as well as 10 $ton{\cdot}ha^{-1}$, respectively [15]. Seeds of 21 days old within seedling trays were pulled out and planted in polybag plastic with one rice crop seed per polybag containing 10 kg of lowland swamp soil that had previously been submerged for about 30 days. These planting media were added to fertilizers as follows: full dose of N = 46 $kg{\cdot}ha^{-1}$, half dose of N = 23 $kg{\cdot}ha^{-1}$, SP 36 = 128 $kg{\cdot}ha^{-1}$, and KCl = 100 $kg{\cdot}ha^{-1}$. These fertilizers were submerged into soil at depth of 10 cm. Submergence was done by putting rice crops into tray that had been filled with dirty water (equivalent to 500 g soil/100 l water) with submergence period of 7 days. Minimum water submergence was 15 cm above plant surface. Rearing was in form of maintaining water submergence height during treatment period.

2.4. Yield and Observation. Observation of agronomical characteristics consisted of percentage of surviving 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 consisted of number of grains per panicle, 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. When ANOVA indicated a significant F-value, multiple comparisons of mean values were performed by the least significant difference test at $\alpha = 0.05$. Relationship between variables observations is sought by correlation. Data were processed using SAS program Portable 9.1.3 for the F test and SPSS 19 for correlation.

3. Results

3.1. Soil Chemical Properties Prior to Treatment. Analysis results of soil chemical properties prior to treatment (Table 2) showed that soil used in this research were lowland swamp soil with very acid reaction, low C-organic content, and low total-N content. Low availability of phosphorus nutrient and low K-dd in this soil showed that effort of fertilizer application could overcome low nutrients availability and could increase rice crop yield.

3.2. Percentage of Survive Plant. Percentage of live crops decreased in IR 64 varieties which experienced two times soaking (N3, N4) compared with one time soaking (N1, N2) (Table 2). While Inpara 5 varieties have a high percentage of live plants (100%) despite having two times soaking. Percentage of live crops in treatment of IR 64 varieties treated with full N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest live plant percentage, which was 66.7 percent.

3.3. Plant Height. With the stress of the soaking effects on plant height at 42 hst observation, plant height of rice varieties having two times soaking periods (N3, N4) decreased compared to one time immersion (N1, N2) (Table 3). Plant height of two rice varieties in the same immersion conditions was not significant for each fertilizer treatment but tended to differ significantly between the immersion treatments. Treatment of IR 64 varieties given full dose N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest plant height of 85.2 cm and the greatest plant height in treatment was given by only 1/2 the dose of N fertilizer at planting time, and the rest was administered at 42 hst with 7–14 hst immersion (V1N2), which was 108.3 cm, and the plant height in this treatment showed no significant difference with nonimmersion treatment (V1N0).

3.4. Number of Productive Tillers. The number of productive tillers decreased in the rice varieties with two times immersion (N3, N4) compared to one time immersion (N1, N2) (Table 3). Two rice varieties experiencing the same immersion conditions resulted in a number of no significant difference productive tillers for each fertilization treatment, but significantly different for the immersion treatment. Treatment of IR 64 varieties given full dose of N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest number of productive tillers, that is, 13.2 tillers, the highest number of tillers in the treatment of Inpara 5 was given 1/2 dose N fertilizer at planting time, and the rest was given at 42 hst with immersion of 7–14 hst (V2N2), which was 30.8 tillers; besides, the number of productive tillers in this treatment showed no significant difference with treatment without immersion (V2N0).

3.5. Plant Dry Matter Weight. Plant dry matter weight was decreased in rice varieties with two times immersion (N3, N4) compared to one immersion (N1, N2) (Figure 1). Two rice varieties experiencing the same immersion conditions

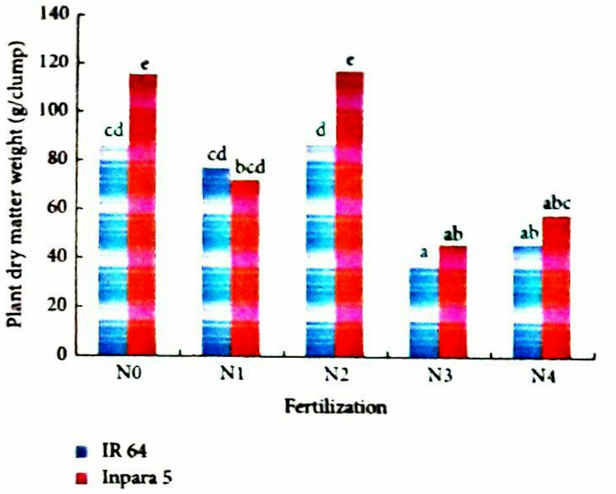


Figure 1: Plant dry matter weight at the end of research for two rice varieties and fertilizing treatment at condition of dirty water submergence stress. N0: without submergence, all N fertilizer was given during planting; N1: with submergence during 7–14 days after planting, N fertilizer was given during planting; N2: with submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3, with submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: with submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant difference or $LSD_{0.05}$: 27.9.

resulting in different dry weight of plants were not significant for each fertilization treatment but differed significantly for immersion treatment. Treatment of IR 64 varieties given full dose N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest dry weight plant, that is, 37.5 g/clump, and highest dry weight in treatment Inpara 5 which was given 1/2 fertilizer dose N at planting time, and the rest was administered at 42 hst with immersion of 7–14 hst (V1N2), which was 117,5 g/clump; besides, the amount of dry weight of plant in this treatment showed no significant difference with nonimmersion treatment (V2N0).

3.6. Yield and Yield Components. Arrangement of nitrogen fertilizer supply affects the yield and component of grain yield per clump. Results and components of grain yield per clump were decreased in rice varieties with two times immersion (N3, N4) compared to one immersion (N1, N2) (Figure 2 and Table 5). Treatment of IR 64 varieties given full dose N fertilization with immersion of 7–14 and 28–35 hst (V1N3) had the lowest grain yield, that is, 58.3 g/clump and highest grain yield on treatment Inpara 5 which was given 1/2 dose N fertilizer at planting time, and the rest was given at 42 hst with immersion of 7–14 hst (V1N2), which was 88.6 g/clump; besides, the grain yield on this treatment also showed no
1 significant difference with nonimmersion treatment (V2N0).

Furthermore, there is a very strong relationship pattern between grain yield per clump with dry weight of plant per clump, with the equation $Y = 55{,}137 + 0{,}259X$; $R^2 = 0{,}817$ (Figure 3). The higher the dry weight of the plant, the higher the yield of grain obtained. 2

4. Discussion

Analysis results of soil chemical properties prior to treatment (Table 1) showed that soil used in this research was lowland swamp soil with very acid reaction, low C-organic content, and low total-N content. Low availability of phosphorus nutrient and low K-dd in this soil showed that effort of fertilizer application could overcome low nutrients availability and could increase rice crop yield.

The immersion stress has an effect on the tolerance, growth, and yield of grain per clump of rice plants, as seen from the changes of life plant percentage, plant height, number of productive tillers, dry weight of plant and also some components of yield.

Crop tolerance is the ability of plants to avoid or reduce damage to crops with the presence of soaking stress so as to grow and produce as in plants that do not experience the immersion stress. The longer and more frequent the rice plants experience soaking stress, the greater the damage that occurs in plants. The regulation of N fertilizer application statistically was not significant but it showed a tendency of increasing the percentage of live plants by 16.6 percent. According to [10], N fertilizer application was the proper measure to decrease negative effect of submergence stress on crop. Moreover, according to [16], recovery capacity highly depends on plant capability to adapt quickly to certain condition after they experience flooding stress. In addition, [4] stated that better recovery for rice plant which experienced submergence stress was indicated by faster new tillers emergence so that plant had relatively same tiller numbers or even higher tiller numbers than that of plant which did not experience submergence stress.

Management of N fertilizer application had effect on rice plant height. Rice variety which was treated with half dose of N fertilizer during planting time (and the rest was given at 42 days after planting) either received one time submergence or two times submergence and tends to have higher plant height than that of other fertilizing treatments. IR 64 rice variety even with one time submergence had higher plant height than without submergence treatment with magnitude of 107.5 cm. According to [11], management of N fertilizer application had effect on plant height and increment rate of plant height. In addition, [12] stated that plant height after flooding stress period was more affected by rice variety than by fertilization treatment. The papers [17–19] also stated that the increase in plant height becomes more noticeable with prolonged submergence.

Rice varieties which experienced submergence stress treated with half dose of N fertilizer during planting time (and the rest was given at 42 days after planting) tend to have higher plant dry matter weight than that of other fertilizing treatments; even IR 64 and Inpara 5 varieties which

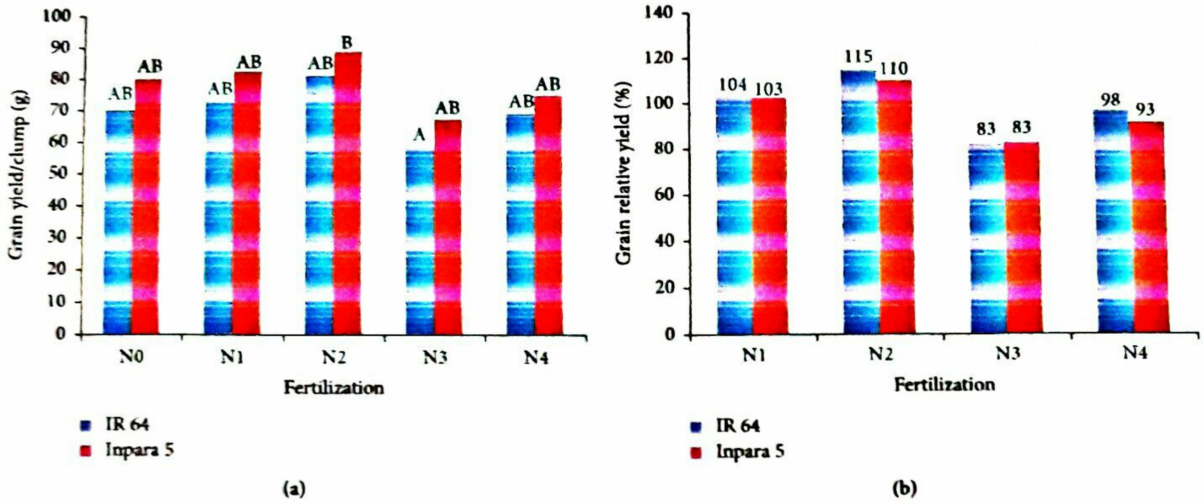


FIGURE 2: Fertilizing treatment effect for two rice varieties on grain yield (a) and relative grain yield (b) at condition of dirty water submergence stress. N0: without submergence, all N fertilizer was given during planting; N1: for submergence during 7–14 days after planting, N fertilizer was given during planting; N2: for submergence during 7–14 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3: for submergence during 7–14 and 28–35 days after planting, all N fertilizer dose was given during planting; N4: for submergence during 7–14 and 28–35 days after planting, 1/2 dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at least significant difference or $LSD_{0.05}$: 28.7.

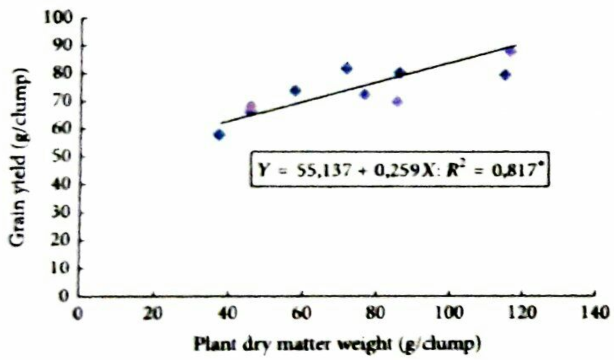


FIGURE 3: Relationship pattern between plant dry matter weight and grain yield. $^*R^2$ = 0,817 is the value of the goodness of fit between grain yield per clump and dry weight of plant per clump.

experienced one time submergence tend to have higher plant dry matter weight than that of without submergence with magnitude of 86.7 g and 117.2 g, respectively. This was due to the fact that varieties treated with this fertilizer had higher plant height and higher tiller numbers than the other fertilizing treatments so that dry matter weight of these varieties was also high. According to [20], the weight increasing of plant dry is an indicator of growth and development of increasing plant. In addition, [21] stated that postsubmergence stem dry weight correlated positively and strongly with survival (r = 0,97).

Inpara 5 variety treated with half dose of N fertilizer during planting time (and the rest was given at 42 days after planting) showed higher grain yield than that of other treatments, either for one time submergence or for two times submergence with grain yield of 88.6 g and 73.4 g, respectively. This was in accordance with high change of plant dry matter weight in this treatment resulting in high capability of plant to distribute assimilates into generative organ so that stem can produce more full grain which was shown by the change of several yield components on this treatment (Table 5). Study results from [22] showed that fertilization with half dose of Urea fertilizer during planting as well as Si and Zn in which the remainder was applied at 42 days after planting had produced the highest grain yield for all tested varieties for flooding period of 7 to 14 days after planting.

Moreover, there was very close relationship pattern between grain yield per clump and plants dry matter weight per clump expressed by equation of $Y = 55.137 + 0.259X$; $R^2 = 0.817$ (Figure 3). The higher the plants dry matter weight, the higher the obtained grain yield. In addition, the research result of [23] reported that the grain yield also has very real relationship to the nitrogen content ($r > 0.73^{**}$). 3

5. Conclusions

The results showed that management of nitrogen fertilizer application had effect on rice growth and production which experienced dirty water submergence stress. Application of half dose of N fertilizer during planting time (and the rest was given at 42 days after planting) was the best treatment in terms of rice growth and production. The longer the submergence period on rice variety, the bigger the effect on rice growth and production. 4

5

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors especially wish to acknowledge the Ministry of Research, Technology and Higher Education that had already provided funding for this research through Competitive Research Grant *(Hibah Bersaing)* for fiscal year of 2015.

References

[1] C. Aydinalpn and M. S. Cresser, "The effect of global climate change on agriculture," *American-Eurasian Journal of Agricultural & Environmental Sciences*, vol. 3, pp. 672–676, 2008.

[2] E. M. Septiningsih, A. M. Pamplona, D. L. Sanchez et al., "Development of submergence tolerant rice cultivars: the Sub1 locus and beyond," *Annals of Botany*, vol. 103, no. 2, pp. 151–160, 2009.

[3] Badan Perencanaan Pembangunan Nasional (Bappenas), "Indonesia Climate Change Sectoral Roadmap (ICCSR) of agrcultural sector," Tech. Rep., 2010, http://bappenas.go.id.

[4] A. K. Makarim, E. Suhartatik, G. R. Pratiwi, and Ikhwani, "Assembly of rice production technology on swamp land and flooding prone swamp (>15 days) for minimum productivity of 7 t ha^{-1}," A Final Report of ROPP DIPA, Indonesian Rice Research Institute, Indonesian Agricultural Research and Development, 2009.

[5] Ikhwani, "Resistency of submergence tolerant rice variety and its response to fertilizers," *Jurnal Lahan Suboptimal*, vol. 2, no. 1, pp. 1–13, 2013.

[6] A. M. Ismail, U. S. Singh, S. Singh, M. H. Dar, and D. J. Mackill, "The contribution of submergence-tolerant (Sub1) rice varieties to food security in flood-prone rainfed lowland areas in Asia," *Field Crops Research*, vol. 152, pp. 83–93, 2013.

[7] U. S. Singh, M. H. Dar, S. Singh et al., "Field performance, dissemination, impact and tracking of submergence tolerant (Sub1) rice varieties in South Asia," *Sabrao Journal of Breeding and Genetics*, vol. 45, no. 1, pp. 112–131, 2013.

[8] D. J. Mackill, A. M. Ismail, U. S. Singh, R. V. Labios, and T. R. Paris, "Development and rapid adoption of submergence-tolerant (Sub1) rice varieties," *Advances in Agronomy*, vol. 115, pp. 299–352, 2012.

[9] IRRI and The Research and Development Council of Food Crops, *Submergence Tolerant Rice*, Food Crops Research and Development Center, 2009.

[10] S. T. Reed and G. G. Gordon, "Nitrogen fertilization effects on recovery of bush beans from flooding," *International Journal of Vegetable Science*, vol. 14, no. 3, pp. 256–272, 2008.

[11] R. A. Suwignyo, F. Zulvica, and Hendryansyah, "Technological adaptation for rice production at lowland swamp area: the effort to prevent the negative effect of rice crop flooding through regulation of nitrogen fertilizer application," in *Proceedings of the 3rd National Seminar on Rice Day*, Indonesian Rice Research Institute, Sukamandi, Indonesia, July 2008.

[12] R. A. Gribaldi, M. Suwignyo, R. Hasmeda, and R. Hayati, "The effect of fertilization on morphophysiological changes of two rice varieties under submergence stress," *Jurnal Agronomi Indonesia*, vol. 42, no. 1, pp. 17–23, 2014.

[13] R. A. Suwignyo, F. Zulvica, and L. Hakim, "The response of several rice varieties to nitrogen treatment in seedling and silica application through coal ash residue," in *Proceedings of the 3rd National Seminar on Rice Day*, Indonesian Rice Research Institute, Sukamandi, Indonesia, July 2008.

[14] R. A. Gribaldi, M. Suwignyo, R. Hasmeda, and R. Hayati, "The arrangement of nitrogen fertilizer application to increase the rice plant tolerance and recovery to the submerged stress," *Jurnal Lahan Suboptimal*, vol. 2, no. 2, pp. 151–158, 2013.

[15] R. A. Suwignyo, A. Wijaya, H. Sihombing, and G. Gribaldi, "Modification of nutrients application to improve rice seeds vigor in submergence condition," *Jurnal Lahan Suboptimal*, vol. 1, no. 1, pp. 1–11, 2012.

[16] Gribaldi, R. A. Suwignyo, M. Hasmeda, and R. Hayati, "Fertilization strategy to increase rice growth and production under two flooding condition on two lowland swamp types," *Agrivita*, vol. 38, no. 1, pp. 64–72, 2016.

[17] A. Anandan, G. Rajiv, A. Ramarao, and M. Prakash, "Internode elongation pattern and differential response of rice genotypes to varying levels of flood water," *Functional Plant Biology*, vol. 39, no. 2, pp. 137–145, 2012.

[18] B. Wang, Y. J. Zhou, Y. Z. Xu, G. Chen, Q. F. Hu, and W. G. Wu, "Effect effects of waterlogging stress on growth and yield of middle season rice at the tillering stage," *China Rice*, vol. 20, pp. 68–75, 2014.

[19] M. B. Jackson, "Ethylene-promoted elongation: an adaptation to submergence stress," *Annals of Botany*, vol. 101, no. 2, pp. 229–248, 2008.

[20] E. Mungara, D. Indradewa, and R. Rogomulyo, "Analysis of growth and rice yields (Oryza sativa L.) conventional, organic transitional and organic farming system," *Jurnal Vegetalika*, vol. 2, no. 3, pp. 1–12, 2013.

[21] S. Singh, D. J. Mackill, and A. M. Ismail, "Physiological basis of tolerance to complete submergence in rice involves genetic factors in addition to the SUB1 gene," *AoB PLANTS*, vol. 6, Article ID plu060, 2014.

[22] Gribaldi, *Agronomical treatment to increase rice crop's tenacity and recovery toward submergence stress [Ph.D. thesis]*, Faculty of Agriculture, Sriwijaya University, Palembang, Indonesia, 2013.

[23] Y. Zhang, Z. Wang, L. Li et al., "Short-term complete submergence of rice at the tillering stage increases yield," *PLoS ONE*, vol. 10, no. 5, Article ID e0127982, 2015.

Composition Comments

1. We added "*" after "0,817" into Figure 3. Please check

2. We made the highlighted changes. Please check.

3. Please check the correctness of the highlighted part; as there are no small "*r*" nor "**".

4. Regarding ref [1]: We updated this reference with the full journal name. Please check.

5. Regarding [3]: Please check the update we applied to this reference.

9734036: Your manuscript has been accepted

Dari: Allen Barker (ija@hindawi.com)

Kepada: gribaldi64@yahoo.co.id

Cc: barker@pssci.umass.edu; lelinurlaili66@gmail.com; nurmaladewitjekdin@gmail.com; ekadanial20@gmail.com; firnafpubr@gmail.com; rujito62@yahoo.com

Tanggal: Minggu, 4 Juni 2017 18.56 GMT+7

Dear Dr. Gribaldi,

The review process of Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" by Gribaldi Gribaldi, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena and Rujito Agus Suwignyo submitted to International Journal of Agronomy has been completed. I am pleased to inform you that your manuscript has now been accepted for publication in the journal.

The publication process of your manuscript will be initiated upon the receipt of electronic files. Please log in to the Manuscript Tracking System at the link below using your username and password, and upload the electronic files of your final accepted version within the next 2-3 days.

http://mts.hindawi.com/author/9734036/upload.files/

The electronic files should include the following:

1- Source file of the final accepted manuscript (Word or TeX/LaTeX).
2- PDF file of the final accepted manuscript.
3- Editable figure files (each figure in a separate EPS/PostScript/Word file) if any, taking into consideration that TIFF, JPG, JPEG, BMP formats are not editable.

Thank you again for submitting your manuscript to International Journal of Agronomy.

Best regards,

Allen Barker
barker@pssci.umass.edu

Judul **9734036: Electronic Files Needed**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: lelinurlaili66@gmail.com; nurmaladewitjekdin@gmail.com; ekadanial20@gmail.com; firnafpubr@gmail.com; rujito62@yahoo.com
Tanggal: Rabu, 7 Juni 2017 10.31.27 WIB

Dear Dr. Gribaldi,

We have not received the electronic files needed for Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" by Gribaldi Gribaldi, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena and Rujito Agus Suwignyo.

The production process of your manuscript will start upon the receipt of the electronic files. Please log in to the Manuscript Tracking System at the link below using your username and password, and upload the electronic files of your final accepted version within the next 2 days.

http://mts.hindawi.com/author/9734036/upload.files/

The electronic files should include the following:

1- Source file of the final accepted manuscript (Word or TeX/LaTeX).
2- PDF file of the final accepted manuscript.
3- Editable figure files (each figure in a separate EPS/PostScript/Word file) if any, taking into consideration that TIFF, JPG, JPEG, BMP formats are not editable.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com
****

Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress

Gribaldi,[1] Nurlaili,[1] Nurmala Dewi,[1] Ekawati Danial,[1] Firnawati Sakalena,[1] and Rujito A. Suwignyo[2]

[1] *Faculty of Agriculture, University of Baturaja, Jl. RatuPenghulu No. 02301 Karang Sari Baturaja 32115, South Sumatra, Indonesia.*
[2] *Faculty of Agriculture, Sriwijaya University, Jl. Palembang-Prabumulih KM 32 Ogan Ilir, South Sumatra*

Correspondence should be addressed to Gribaldi; gribaldi64@yahoo.co.id

This research was conducted from July to October 2015, use Randomized Block Design with two treatment factors and three replications for each treatment. The first factor was rice varieties (V): V1= IR 64; V2= Inpara 5. The second factor was fertilizer (N): N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = All N fertilizer dose was given during planting and N2 = ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Submergence during 7-14 days after planting; N3 = All N fertilizer dose was given during planting and N4 = ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Submergence during 7-14 and 28-35 days after planting. The results showed that management of nitrogen fertilizer application had effect on rice growth and production which experienced dirty water submergence stress, application of ½ dose of N fertilizer given during planting and the rest was given at 42 days after planting had the best effect on rice growth and production, the longer submergence period for rice variety had produced higher effect on rice growth and production.

1. Introduction

Food crop production, especially rice (*Oryza sativa* L.) should be increased in annual basis according to the increase of population growth. The increase of production can be done through productivity improvement at submergence stress prone areas which is considered as the main constraint in rice crop cultivation. The area of rice production centers which are mostly located in lowland areas would be extremely vulnerable to the growing possiblity of flooding [7]. According to [10], submergence that causes stress on rice crop at South Asia and Southeast Asia areas was estimated of about 15 million hectares per year, whereas flooding prone paddy field areas at South Sumatra was 124,465 ha [5].

Submergence stress on crop causes the obstacle of crop growth and production. This is due to gas diffusion within water is 10^4 times slower than gas diffusion within air [24] and very low light penetration that is received by plants [20]. Estimated yield loss due to flood was about 1.1 million tons of unhulled rice per year or equivalence to yield loss of 0.66 million tons of hulled rice [2]. Rice productivity in areas planted in this way is low and unstable, averaging <2.0 t ha^{-1} in rainfed lowlands and <1.5 t ha^{-1} in flood-prone areas, compared with yields of >5.0 t ha^{-1} in input-intensive irrigated systems [4,23]. This results in serious crop losses and sometimes leads to severe food shortages in flood-affected regions [8].

Rice variety of IR 64 was developed by IRRI in 2006 which was subsequently converted into IR 64 *Sub-1* (Inpara 5) variety by transferring *Sub-1* gene from FR13A species which is tolerant to submergence condition. This variety is capable to decrease harvest loss risk during wet season due to unpredictable change of climate [10].

The decrease of unhulled rice yield due to submergence for rice variety containing Sub-1 gene was lower than that of rice variety not containing Sub-1 gene. The yield decrease on IR 64 rice variety *Sub-1* was 16 percent, whereas IR 64 rice variety without *Sub-1* gen was 39 percent [15]. According to [2], rice yield loss was about 30 percent due to submergence condition and if this loss can be reduced to less than 10 percent through agronomical treatment, then it has high significant contribution for farmers and increment of national rice production.

In addition to the use of tolerant rice variety to submergence stress, proper fertilizing technique can also minimize the decrease of rice yield due to submergence condition. Fertilizing treatment before crop was submerged might maintain crop survival at submergence condition. According to [22], N fertilizing might be a proper measure to minimize negative impact from submergence stress on crop. Management treatment of nitrogen fertilizer application will give significant effect on crop height and height increment rate of rice crop. These two parameters on rice crop usually will more affected with submergence condition of more than three days [17]. The stem length increment rate during occurrence of submergence stress had significant effect on rice crop tolerance and crop recovery rate after submergence stress [3,18]. Moreover, study results by [12] showed that rice variety given half dose of Urea during planting period added with (Si +Zn) fertilizer tend to show better vegetative and generative growths.

The research objective was to determine the best fertilization that can increase rice crop tolerance toward submergence stress.

2. Materials and Methods

This research was conducted from July to October 2015 at Experimental Plot of Agricultural Faculty, Baturaja Unversity. The experimental design used in this research was Randomized Block Design with two treatment factors and three replications for each treatment as well as one crop clump for each treatment unit. The first factor was rice varieties (V) consisting of V1 = IR 64 and V2 = Inpara 5. The second factor was fertilizer (N) treatments consisting of N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

Rice variety seeds were incubated for 3 days and after germination period they were put into platic trays media with dimension of 40 cm in length, 30 cm in width and 13 cm in depth. These trays previously were filled with 15 kg of lowland swamp soil treated with fertilizers of N, P, K, Si and Zn as well as manure at doses of 60, 40, 40, 30 and 20 $kg.ha^{-1}$ as well as 10 $ton.ha^{-1}$, respectively [19]. Seed having 21 days old within seedling trays were pulled out and planted in polybag plastic with one rice crop seed per polybag containing of 10 kg of lowland swamp soil that hd previously submerged for about 30 days. These planting media were added with fertilizers as follows: full dose of N = 46 $kg.ha^{-1}$, half dose of N = 23 $kg.ha^{-1}$, SP 36 = 128 $kg.ha^{-1}$, KCl = 100 $kg.ha^{-1}$. These fertlizers were submerged into soil at depth of 10 cm. Submergence was done by putting rice crops into tray that had been filled with dirty water (equivalence to 500 g soil/100 l water) with submergence period of 7 days. Minimum water submergence was 15 cm above plant surface. Rearing was in form of maintaining water submergence height during treatment period.

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, percentage of filled grains per panicle (%) and 100 grain weight (g).

3. Results and Discussion

Results of variance analysis (Table 1) showed that variety treatments had significant effect on each parameter except for parameter of weight of 100 unhulled rice grains, whereas fertilizer treatments had no significant effect on each parameter except for parameter of productive tiller numbers. Interaction between variety and fertilizer treatments had no significant effect on each parameter except for parameter of crop's dry weight.

3.1. *Soil Chemical Properties Prior to Treatment*

Analysis results of soil chemical properties prior to treatment (Table 2) showed that soil used in this research were lowland swamp soil with very acid reaction, low C-organic content and low total-N content. Low availability of phosphorus nutrient and low K-dd in this soil showed that effort of fertilizer application could overcome low nutrients availability as well as could increase rice crop yield.

3.2 *Percentage of Survive Plant*

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.

Management of N fertilizer application had significant effect on percentage of survive plant. Application of half dose N fertilizer during planting time and the rest was given at 42 days after planting had results in increase of survive plant percentage for IR 64 rice variety which experienced two times submergence with magnitude of 16.6 percent. This was estimated due to the fact that N fertilizer application had effect on rice crop endurance toward submergence stress condition. According to [22], N fertilizer application was the proper measure to decrease negative effect of submergence stress on crop. Moreover, according to [14], recovery capacity is highly depends on plant capability to adapt quickly to certain condition after they experience flooding stress.

TABLE 1. Variance analysis results of fertilizing treatment effect before submergence for two rice varieties on the observed parameters.

No	Observed parameters	Variety	Fertilization	Interactions
1	Percentage of survive crop	*	ns	ns
2	Crop height	*	ns	ns
3	Productive tiller numbers	*	*	ns
4	Crop dry matter weight	*	ns	*
5	Full Unhulled rice percentage	*	ns	ns
6	Unhulled rice numbers per stem	*	ns	ns
7	Weight of 100 unhulled rice	ns	ns	ns
8	Unhulled rice yield per clump	*	ns	ns

Notes: * = significant effect
ns = no significant effect

TABLE 2. Analysis results of soil properties before treatment

Analyses	Unit	Result	Status
pH H_2O		4.03	Very acid
C-Organic	%	1.82	Low
N-Total	%	0.17	Low
P-Bray I	ppm	13.65	Low
K-dd	$me.100g^{-1}$	0.26	Low
Na	$me.100g^{-1}$	0.22	Low
Ca	$me.100g^{-1}$	1.30	Very low
Mg	$me.100g^{-1}$	0.25	Very low
CEC	$me.100g^{-1}$	13.08	Low
Al-dd	$me.100g^{-1}$	1.00	Very low

Source: Soil Science Laboratory, Faculty of Agriculture, Unsri, 2015

3.3 *Plant Height.* Submergence stress had effect on plant's height, i.e. rice variety which experienced two times submergence tends to have lower plant's height than that of one time (Table 4).

Management of N fertilizer application had effect on rice plant height. Rice variety which treated with half dose of N fertilizer during planting time and the rest was given at 42 days after planting, either received one time submergence or two times submergence, tend to have higher plant height than that of other fertilizing treatments. IR 64 rice variety even with one time submergence had higher plant height than without submergence treatment with magnitude of 107.5 cm. According to [17], management of N fertilizer application had effect on plant's height and increment rate of plant's height. In addition [13], stated that plant height after flooding stress period was more affected by rice variety than by fertilization treatment. [1, 6, 16], also stated that that the increase in plant height becomes more noticeable with prolonged submergence

3.4 *Number of Produktive Tillers.* Result of study related to number of productive tillers on rice variety tend to decrease by treatment of two times submergence than that of one time submergence treatment (Tabel 5).

Inpara 5 variety treated with half dose of N fertilizer during planting time and the rest was given at 42 days after planting tend to have more productive tiller numbers and even higher plant height than that of without submergence treatment, i.e. with magnitude of 30.8 tillers. This was due to the fact that Inpara 5 variety had faster recovery rate against submergence stress which facilitate faster new tillers emergence and subsequently had also produced more productive tiller numbers. According to [2] showed that better recovery for rice plant which experienced submergence stress was indicated by faster new tillers emergence so that plant had relatively same tiller numbers or even higher tiller numbers than that of plant which not experienced submergence stress.

TABLE 3. Percentage of survive plant (%) of two rice varieties and fertilizing treatment in condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR 64	100.0	100.0	100.0	66.7	83.3
Inpara 5	100.0	100.0	100.0	100.0	100.0

Notes: N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

TABLE 4. Plant height (cm) at 42 days after planting of two rice varieties and fertilizing treatment at condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR64	107.0	104.2	108.3	85.2	99.3
Inpara 5	109.1	103.5	107.5	90.7	101.0

Notes : N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

TABLE 5. Productve tiller numbers of two rice varieties and fertilizing treatment at condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR64	26.0	25.2	25.7	13.2	15.8
Inpara 5	27.7	26.7	30.8	16.7	18.7

Notes : N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

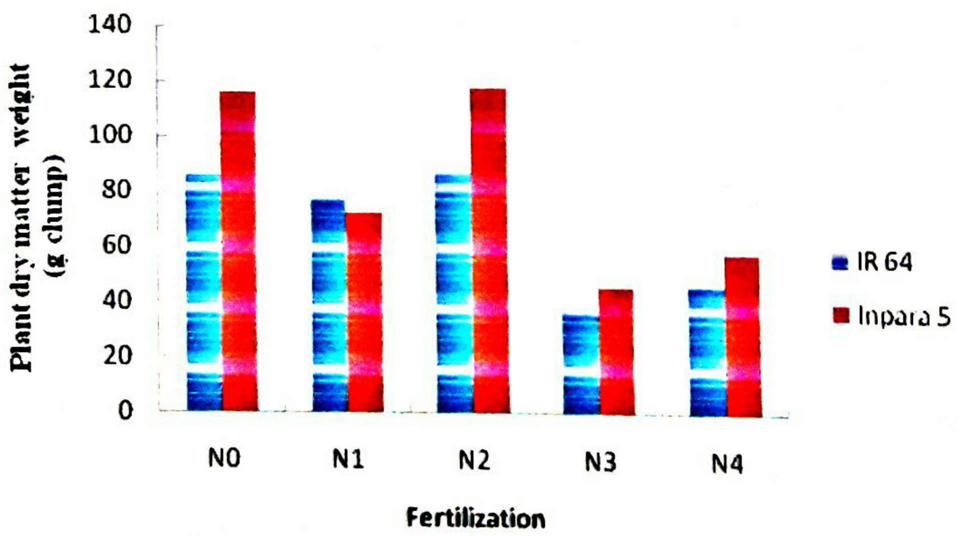
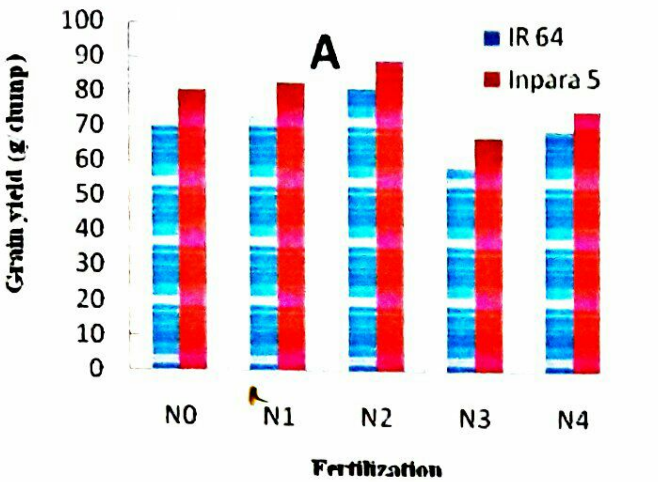


FIGURE 1. Plant dry matter weight at the end of research for two rice varieties and fertilizing treatment at condition of dirty water submergence stress. N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

3.5 *Plant Dry Matter Weight.* Plant dry matter weight of IR 64 and Inpara 5 which experienced two times submergence were lower than that of one time submergence (Figure 1).

Rice varieties which experienced submergence stress treated with half dose of N fertilizer during planting time and the rest was given at 42 days after planting tend to have higher plant dry matter weight than that of other fertilizing treatments, even IR 64 and Inpara 5 varieties which experienced one time submergence tend to have higher plant dry matter weight than that of without submergence with maganitude of 86.7 g and 117.2 g, respectively. This was due to the fact that varieties treated with this fertilizing had higher plant height and higher tiller numbers than that of other fertilizing treatments so that dry matter weight of these varieties were also high. According to [9], the weight increasing of plant dry is an indicator of growth and development of increasing plant. In addition [21] stated that post-submergence stem dry weight correlated positively and strongly with survival (r = 0,97).



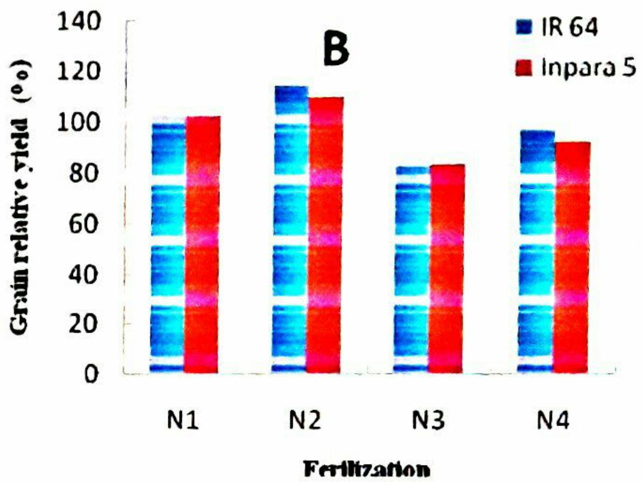


FIGURE 2. Fertilizing treatment effect for two rice varieties on grain yield (A) and relative grain yield (B) at condition of dirty water submergence stress. N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

TABLE 6. The fertilizing effect for two rice varieties on several yield components at condition of dirty water submergence stress

Treatment	Inpara 5			IR64		
	1	2	3	1	2	3
N0	130.8	93.0	2.39	128.5	91.0	2.49
N1	123.2	90.1	2.37	118.7	91.7	2.38
N2	128.9	93.2	2.36	129.7	92.6	2.42
N3	101.3	89.5	2.32	110.8	89.2	2.37
N4	112.3	91.8	2.44	122.1	91.1	2.41

Remarks: 1: The number of grains per panicle (grains), 2: Percentage of grain pithy (%), 3: grain weight of 100 grains (g). N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

3.6. *Yield and Yield Components.* The results of study related to grain yield per clump and several yield components tend to decrease for rice varieties which experienced two times submergence were lower than that of one time submergence (Figure 2 and Table 6). Management of nitrogen fertilizer application had effect on grain yield per clump and several yield components. Inpara 5 variety treated with half dose of N fertilizer during planting time and the rest was given at 42 days after planting showed higher grain yield than that of other treatments, either for one time submergence or two times submergence with grain yield of 88.6 g and 73.4 g, respectively. This was in accordance to high change of plant dry matter weight in this treatment resulting in high capability of plant to distribute assimilates into generative organ so that stem can produce more full grain which was shown by the change of several yield components on this treatment (Table 6). Study results from [11] showed that fertilization with half dose of Urea fertilizer during planting as well as Si and Zn in which the remainder was applied at 42 days after planting had produced the highest grain yield for all tested varieties for flooding period of 7 to 14 days after planting.

Moreover, there was very close relationship pattern between grain yield per clump and plant's dry matter weight per clump expressed by equation of $Y = 55.137 + 0.259X$: $R^2 = 0.817^*$ (Figure 3). The higher the plant's dry matter weight, the higher was the obtained grain yield. In addition, the research result of [25] reported that the grain yield also has very real relationship to the nitrogen content ($r > 0.73^{**}$).

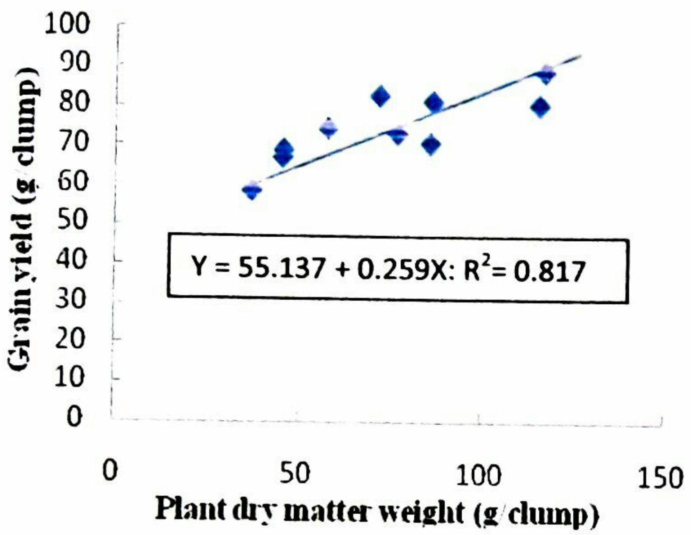


Figure 3. Relationship pattern between plant dry matter weight and grain yield.

4. Conclusions

The results showed that management of nitrogen fertilizer application had effect on rice growth and production which experienced dirty water submergence stress. Application of half dose of N fertilizer during planting time and the rest was given at 42 days after planting was the best treatment in term of rice growth and production. The longer the submergence period on rice variety, the bigger was the effect on rice growth and production.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

We especially wish to acknowledge the Ministry of Research, Technology and Higher Education that had already provided funding for this research through Competitive Research Grant (*Hibah Bersaing*) for fiscal year of 2015.

References

1. A. Anandan, G. Rajiv, A. Ramarao, and M. Prakash. "Internode Elongation Pattern and Differential Response of Rice Genotypes to Varying Level of Flood Water". *Functional Plant Biology*, vol. 39, pp. 137-145, 2012.
2. A.K. Makarim, E. Suhartatik, G.R. Pratiwi and Ikhwani. *Assembly of rice production technology on swamp land and flooding prone swamp (>15 days) for minimum productivity of 7 t ha-1* (in Indonesian), A Final Report of ROPP DIPA 2009. Indonesian Rice Research Institute. Indonesian Agricultural Research and Development, 2009.
3. A. M. Ismail, G. Vergara and D.J. Mackill. *Towards Enhanced and Sustained Rice Productivity in Flood-Prone Areas of South and Southeast Asia*, The 3rd National Seminar on Rice Day, Indonesian Rice Research Institute, Sukamandi 22-24 July 2008, 2008.
4. A.M. Ismail , U. Singh, S. Singh, M.H. Dar, and D.J. Mackill. "The contribution of submergence-tolerant (Sub1) rice varieties to food security in flood-prone rainfed lowland areas in Asia ". *Field Crops Research*, vol. 152, pp. 83–93, 2013.
5. Badan Perencanaan Pembangunan Nasional. *Indonesia Climate Change Sectoral Roadmap (ICCSR) of Agrcultural Sector*, http://bappenas.go.id, 2010.
6. B. Wang, Y.J. Zhou, Y.Z. Xu, G. Chen, Q.F. Hu, and W.G. Wu. "Effect Effects of Waterlogging Stress on Growth and Yield of Middle Season Rice at the Tillering Stage". *China Rice*, vol. 20, pp. 68–75, 2014.
7. C. Aydinalpn, M.S. Cresser. "The effect of global climate change on agriculture". *American-Eurasian J. Agric. Environ. Sci.*, vol. 3, pp. 672-676, 2008.
8. D.J. Mackill, A.M. Ismail, U.S. Singh, R.V. Labios, and T.R. Paris. "Development and rapid adoption of submergence-tolerant (Sub1) rice varieties". *Advances in Agronomy*, vol. 115, pp. 299–352, 2012.
9. E. Mungara, D. Indradewa and R. Rogomulyo. "Analysis of Growth and Rice Yields (Oryza sativa L.) Conventional, Organic Transitional and Organic Farming System" (in Indonesia with an abstract in English). *Jurnal Vegetalika*, vol. 2, no. 3, pp. 1-12, 2013.
10. E.M. Septiningsih, A.M. Pamplona, D.L. Sanches, C.N. Neeraja, G.V. Vergara, S. Heuer, A.M. Ismail and D.J. Mackill. " Development of Submergence-Tolerant Rice Cultivars: The Sub1 Locus and Beyond". *Ann. Bot.*, vol. 103, no. 2, pp. 151-160, 2009.
11. Gribaldi. *Agronomical Treatment to Increase Rice Crop's Tenacity and Recovery Toward Submergence Stress*, Doctoral Dissertation, Postgraduate School Program, Faculty of Agriculture, Sriwijaya University, Palembang, 2013.

12. Gribaldi, R.A. Suwignyo, M. Hasmeda and R. Hayati. "The Arrangement of Nitrogen Fertilizer Application to Increase The Rice Plant Tolerance and Recovery to The Submerged Stress" (in Indonesian with an abstract in English). *Jurnal Lahan Suboptimal*, vol. 2, no. 2, pp.151-158, 2013.
13. ______________________________________ ______." The Effect of Fertilization on Morphophysiological Changes of Two Rice Varieties Under Submergence Stress" (in Indonesian with an abstract in English). *Jurnal Agronomi Indonesia*, vol. 42, no.1, pp.17-23, 2014.
14. ______________________________________ ______. "Fertilization Strategy to Increase Rice Growth and Production Under Two Flooding Condition on Two Lowland Swamp Types". *Int. J. Agrivita*, vol. 38, no. 1, pp. 64-72, 2016.
15. IRRI and The Research and Development Council of Food Crops. *Submergence Tolerant Rice*. Food Crops Research and Development Center, 2009.
16. M.B. Jackson. "Ethylene promoted elongation: an adaptation to submergence stress". *Annals of Botany*, vol. 101, pp. 229–248, 2008.
17. R.A. Suwignyo, F. Zulvica and Hendryansyah. *Technological Adaptation for Rice Production at Lowland Swamp Area: The Effort to Prevent the Negative Effect of Rice Crop Flooding through Regulation of Nitrogen Fertilizer Application*, The 3rd National Seminar on Rice Day, Indonesian Rice Research Institute, Sukamandi 22-24 July 2008, 2008a.
18. R.A. Suwignyo, F. Zulvica and L. Hakim. *The Response of Several Rice Varieties to Nitrogen Treatment in Seedling and Silica Application through Coal Ash Residue*, The 3rd. National Seminar on Rice Day, Indonesian Rice Research Institute, Sukamandi 22-24 July 2008 , 2008b.
19. R.A. Suwignyo, A. Wijaya, H. Sihombing and Gribaldi. "Modification of Nutrients Application to Improve Rice Seeds Vigor in Submergence Condition" (in Indonesia with an abstract in English). *Jurnal Lahan Suboptimal*, vol. 1, no. 1, pp. 1-11, 2012.
20. R. Pierik, F.F. Millenaar, A.J. Peeters and L.A. Voesenek." New Perspectives in Flooding Research: The Use of Shade Avoidance and Arabidopsis Thaliana". *Ann. Bot.*, vol. 96, no. 4, pp. 533-540, 2005
21. S. Singh, D.J. Mackill, and A.M. Ismail. "Physiological Basis of Tolerance to Complete Submergence in Rice Involves Genetic Factors in Addition to *Sub1* Gene". *oB Plant*, vol. 6, doi:10.1093/aobpla/plu060, 2014.
22. S.T. Reed, and G.G. Gordon. " Nitrogen Fertilization Effect on Recovery of Bush Beans from Flooding". *Int. J. Veg. Sci.*, vol. 14, no. 3, pp. 256-272, 2008.
23. U.S. Singh, M.H. Dar, S. Singh, N.W. Zaidi, M.A. Bari, D.J. Mackill, B.C.Y. Collard, V.N. Singh, J.P. Singh, J.N. Reddy, R.K. Singh, and A.M. Ismail. " Field performance, dissemination, impact and tracking of submergence tolerant (Sub1) rice varieties in South Asia". *SABRAO Journal of Breeding and Genetics*, vol. 45, pp. 112–131, 2013.
24. W. Armstrong and M.C. Drew. *Root growth and metabolism under oxygen deficiency*, In: Waisel Y, Eshel A and Kafkafi U, eds. *Plant Roots*, the Hidden Half,3rdedn, New York, Marcel Dekker, pp. 729–761, 2002
25. Y. Zhang, Z. Wang, L. Li, Q. Zhou, Y. Xiao and X. Wei. "Short-Term Complete Submergence of Rice at the Tillering Stage Increases Yield". *PloS ONE*, vol. 10, no. 5, e0127982, 2015.

Judul **9734036: Acknowledging Receipt of Electronic Files**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: sahl.abdelrahman@hindawi.com; lelinurlaili66@gmail.com; nurmaladewitjekdin@gmail.com; ekadanial20@gmail.com; firnafpubr@gmail.com; rujito62@yahoo.com
Tanggal: Kamis, 8 Juni 2017 13.08.32 WIB

Dear Dr. Gribaldi,

This is to confirm the receipt of the electronic files of Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" by Gribaldi Gribaldi, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena and Rujito Agus Suwignyo. We will check all the uploaded files and contact you if anything else is needed.

Thank you for your cooperation.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com
****

Judul **9734036: Electronic Files**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: sahl.abdelrahman@hindawi.com; lelinurlaili66@gmail.com; nurmaladewitjekdin@gmail.com; ekadanial20@gmail.com; firnafpubr@gmail.com; rujito62@yahoo.com
Tanggal: Minggu, 11 Juni 2017 15.45.45 WIB

Dear Dr. Gribaldi,

This is regarding manuscript 9734036 that will be published shortly in International Journal of Agronomy. None of the figures can be edited. We need to be able to edit lines, arrowheads, and fonts to match the journal's style. Each figure should be a separate ps, eps, fig, ai, Visio, wmf, emf, Word, Excel, PowerPoint, opj, cdr, or PDF file which can be edited. Please note that jpg, bmp, png, and tif files cannot be edited by default.

Please access the Manuscript Tracking System at
http://mts.hindawi.com/author/9734036/upload.files/ and upload the file(s) required.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com
****

Judul **9734036: Acknowledging Receipt of Electronic Files**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: sahl.abdelrahman@hindawi.com; lelinurlaili66@gmail.com; nurmaladewitjekdin@gmail.com; ekadanial20@gmail.com; firnafpubr@gmail.com; rujito62@yahoo.com
Tanggal: Minggu, 11 Juni 2017 23.57.49 WIB

Dear Dr. Gribaldi,

This is to confirm the receipt of the electronic files of Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress" by Gribaldi Gribaldi, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena and Rujito Agus Suwignyo. We will check all the uploaded files and contact you if anything else is needed.

Thank you for your cooperation.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
http://www.hindawi.com
****

Judul **9734036: Galley Proofs**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: lelinurlaili66@gmail.com; ekadanial20@gmail.com; nurmaladewitjekdin@gmail.com; rujito62@yahoo.com; firnafpubr@gmail.com
Tanggal: Selasa, 4 Juli 2017 19.41.23 WIB

Dear Dr. Gribaldi,

I am pleased to let you know that the first set of galley proofs of your Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress," is ready. You can apply your corrections directly to the manuscript with the Online Proofing System (OPS).

Using the OPS, authors can quickly and easily make corrections online to their galley proofs and submit these corrections with a single click.

http://ops.hindawi.com/author/9734036/

If you would like to submit your corrections offline instead, please follow this link for other options:

https://mts.hindawi.com/author/9734036/proofs/

To expedite the publication of your manuscript, please send us your corrected galley proofs within three days.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
https://www.hindawi.com
****

Judul **9734036: Galley Proof Corrections**

Dari: sahl.abdelrahman@hindawi.com

Kepada: gribaldi64@yahoo.co.id

Cc: lelinurlaili66@gmail.com; ekadanial20@gmail.com; nurmaladewitjekdin@gmail.com; rujito62@yahoo.com; firnafpubr@gmail.com

Tanggal: Kamis, 6 Juli 2017 14.23.02 WIB

Dear Dr. Gribaldi,

This is to confirm the receipt of the first galley proof corrections of Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress,".

We will address your comments and send you another set of galley proofs.

Thank you for your cooperation.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
https://www.hindawi.com
****

Judul **9734036: Galley Proofs**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: lelinurlaili66@gmail.com; ekadanial20@gmail.com; nurmaladewitjekdin@gmail.com; rujito62@yahoo.com; firnafpubr@gmail.com
Tanggal: Kamis, 6 Juli 2017 20.22.03 WIB

Dear Dr. Gribaldi,

I am pleased to let you know that the second set of galley proofs of your Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress," is ready. You can apply your corrections directly to the manuscript with the Online Proofing System (OPS).

Using the OPS, authors can quickly and easily make corrections online to their galley proofs and submit these corrections with a single click.

http://ops.hindawi.com/author/9734036/

If you would like to submit your corrections offline instead, please follow this link for other options:

https://mts.hindawi.com/author/9734036/proofs/

To expedite the publication of your manuscript, please send us your corrected galley proofs within three days.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
https://www.hindawi.com
****

Judul **9734036: Galley Proof Corrections**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: lelinurlaili66@gmail.com; ekadanial20@gmail.com; nurmaladewitjekdin@gmail.com; rujito62@yahoo.com; firnafpubr@gmail.com
Tanggal: Sabtu, 8 Juli 2017 19.01.15 WIB

Dear Dr. Gribaldi,

This is to confirm the receipt of the second galley proof corrections of Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress,".

We will address your comments and send you another set of galley proofs.

Thank you for your cooperation.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
https://www.hindawi.com
****

Judul 9734036: Galley Proofs

Dari: sahl.abdelrahman@hindawi.com

Kepada: gribaldi64@yahoo.co.id

Cc: lelinurlaili66@gmail.com; ekadanial20@gmail.com; nurmaladewitjekdin@gmail.com; rujito62@yahoo.com; firnafpubr@gmail.com

Tanggal: Minggu, 9 Juli 2017 13.51.26 WIB

Dear Dr. Gribaldi,

I am pleased to let you know that the third set of galley proofs of your Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress," is ready. You can apply your corrections directly to the manuscript with the Online Proofing System (OPS).

Using the OPS, authors can quickly and easily make corrections online to their galley proofs and submit these corrections with a single click.

http://ops.hindawi.com/author/9734036/

If you would like to submit your corrections offline instead, please follow this link for other options:

https://mts.hindawi.com/author/9734036/proofs/

To expedite the publication of your manuscript, please send us your corrected galley proofs within three days.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
https://www.hindawi.com
****

Dear Allen Baker,

Here I enclose the revision of my manuscript. I have revised that the results and discussion be divided into two sections and that a clear conclusion be written in a separate section to show any novel findings from the investigation. I also recheck and correct the English grammar, spelling, and syntax, and the referee recommended that a person well-versed in the English language be consulted. The referee also more up-to-date references be cited and I also have checked the citations in the text and in the list of references cited.

Please notify me when there are still need more revision. Thank you very much.

Gribaldi.

Modified Application of Nitrogen Fertilizer for Increasing Rice Variety Tolerance toward Submergence Stress

Gribaldi,[1] Nurlaili,[1] Nurmala Dewi,[1] Ekawati Danial,[1] Firnawati Sakalena,[1] and Rujito A. Suwignyo[2]

[1]*Faculty of Agriculture, University of Baturaja, Jl. Ratu Penghulu No. 02301 Karang Sari Baturaja 32115, South Sumatra, Indonesia.*
[2] *Faculty of Agriculture, Sriwijaya University, Jl. Palembang-Prabumulih KM 32 Ogan Ilir, South Sumatra*

Correspondence should be addressed to Gribaldi; gribaldi64@yahoo.co.id

This research was conducted from July to October 2015, using Randomized Block Design with two treatment factors and three replications for each treatment. The first factor was rice varieties (V): V1= IR 64; V2= Inpara 5. The second factor was fertilizer (N): N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = All N fertilizer dose was given during planting and N2 = ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Submergence during 7-14 days after planting; N3 = All N fertilizer dose was given during planting, N4 = ½ dose of N fertilizer was given during planting, and the rest was given at 42 days after planting. The submergence was during 7-14 and 28-35 days after planting. The results showed that the management of nitrogen fertilizer application had effect on rice growth and production which experienced dirty water submergence stress, the application of ½ dose of N fertilizer which given during planting and the rest was given at 42 days after planting had the best effect on rice growth and production, the longer submergence period for rice variety had produced, the higher effect on rice growth and production.

1. Introduction

Food crop production, especially rice (*Oryza sativa* L.) should be increased in annual basis according to the increase of population growth. The increase of production can be done through productivity improvement at submergence stress prone areas which is considered as the main constraint in rice crop cultivation. The area of rice production centers which are mostly located in lowland areas would be extremely vulnerable to the growing possibility of flooding [7]. According to [10], submergence that causes stress on rice crop at South Asia and Southeast Asia areas was estimated of about 15 million hectares per year, whereas flood-prone rice field areas at South Sumatra was 124,465 ha [5].

Submergence stress on crop causes the obstacle of crop growth and production. Estimated yield loss due to flood was about 1.1 million tons of unhulled rice per year or equivalence to yield loss of 0.66 million tons of hulled rice [2]. In addition, [15] showed that rice crop which experienced submergence stress can decrease its grain yield with magnitude of 17.5% than the rice crop without submergence stress. One of solution to overcome this problem is through development of high yield rice varieties that are tolerant to submergence stress.

Rice productivity in areas planted in this way is low and unstable, averaging <2.0 t ha^{-1} in rainfed lowlands and <1.5 t ha^{-1} in flood-prone areas, compared with yields of >5.0 t ha^{-1} in input-intensive irrigated systems [4,23]. This results in serious crop losses and sometimes leads to severe food shortages in flood-affected regions [8].

Rice variety of IR 64 was developed by IRRI in 2006 which was subsequently converted into IR 64 *Sub-1* (Inpara 5) variety by transferring *Sub-1* gene from FR13A species which is tolerant to submergence condition. This variety is capable to decrease harvest loss risk during wet season due to unpredictable change of climate [10].

The decrease of unhulled rice yield due to the submergence for rice variety containing Sub-1 gene was lower than the rice variety which not containing Sub-1 gene. The yield decrease on IR 64 rice variety *Sub-1* was 16 percent, whereas IR 64 rice variety without *Sub-1* gen was 39 percent [16]. According to [2], rice yield loss was about 30 percent due to the submergence condition and if this loss can be reduced to less than 10 percent through agronomical treatment, then it has high significant contribution for farmers and increment of national rice production.

In addition to the use of tolerant rice variety to submergence stress, proper fertilizing technique also can minimize the decrease of rice yield due to the submergence condition. Fertilizing treatment before crop was submerged might maintain crop survival at submergence condition. According to [22], N fertilizing might be a proper measure to minimize negative impact from submergence stress on crop. Management treatment of nitrogen fertilizer application will give significant effect on crop height and height increment rate of rice crop. These two parameters on rice crop usually will be more affected with submergence condition of more than three days [18]. The stem length increment rate during occurrence of submergence stress had significant effect on rice crop tolerance and crop recovery rate after submergence stress [13,19]. Moreover, study results by [12] showed that rice variety which given half dose of Urea during planting period added with (Si +Zn) fertilizer tend to show better vegetative and generative growths.

The research objective was to determine the best fertilization that can increase rice crop tolerance toward submergence stress.

2. Materials and Methods

2.1. *Experiment site.* This research was conducted from July to October 2015 at Experimental Plot of Agricultural Faculty, Baturaja Unversity. Research station is situated at altitude 13 m above mean sea level.

2.2. *Experiment design.* The experimental design used in this research was Randomized Block Design with two treatment factors and three replications for each treatment as well as one crop clump for each treatment unit. The first factor was rice varieties (V) consisting of V1 = IR 64 and V2 = Inpara 5. The second factor was fertilizer (N) treatments consisting of N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting (DAP) and N fertilizer was given during planting; N2 = submergence during 7-14 DAP and ½ dose of N fertilizer was given during planting and the rest was given at 42 DAP; N3 = submergence during 7-14 and 28-35 DAP in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 DAP and ½ dose of N fertilizer was given during planting and the rest was given at 42 DAP.

2.3. *Implementation of field research.* Rice variety seeds were incubated for 3 days and after germination period they were put into plastic trays media with dimension of 40 cm in length, 30 cm in width and 13 cm in depth. These trays previously were filled with 15 kg of lowland swamp soil treated with fertilizers of N, P, K, Si and Zn as well as manure at doses of 60, 40, 40, 30 and 20 $kg.ha^{-1}$ as well as 10 $ton.\ ha^{-1}$, respectively [20]. Seed having 21 days old within seedling trays were pulled out and planted in polybag plastic with one rice crop seed per polybag containing of 10 kg of lowland swamp soil that had previously submerged for about 30 days. These planting media were added with fertilizers as follows: full dose of N = 46 $kg.ha^{-1}$, half dose of N = 23 $kg.\ ha^{-1}$, SP 36 = 128 $kg.ha^{-1}$, KCl = 100 $kg.ha^{-1}$. These fertilizers were submerged into soil at depth of 10 cm. Submergence was done by putting rice crops into tray that had been filled with dirty water (equivalence to 500 g soil/100 l water) with submergence period of 7 days. Minimum water submergence was 15 cm above plant surface. Rearing was in form of maintaining water submergence height during treatment period.

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, 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. When ANOVA indicated a significant F-value, multiple comparisons of mean values were performed by the least significant difference test at $\alpha = 0.05$. Relationship between variables observations sought by correlation. Data were processed using SAS program Portable 9.1.3 for the F test and SPSS 19 for correlation.

3. Results

3.1. *Soil Chemical Properties Prior to Treatment.* Analysis results of soil chemical properties prior to treatment (Table 2) showed that soil used in this research were lowland swamp soil with very acid reaction, low C-organic content and low total-N content. Low availability of phosphorus nutrient and low K-dd in this soil showed that effort of fertilizer application could overcome low nutrients availability as well as could increase rice crop yield.

3.2 *Percentage of Survive Plant.* Percentage of live crops decreased in IR 64 varieties which experienced two times soaking (N3, N4) compared with one time soaking (N1, N2) (Table 2). While Inpara 5 varieties have a high percentage of live plants (100%) despite having two times soaking. Percentage of live crops in treatment of IR 64 varieties treated with full N fertilization with immersion of 7-14 and 28-35 hst (V1N3) had the lowest live plant percentage, which was 66.7 percent.

3.3 *Plant Height.* The stress of the soaking effects on plant height at 42 hst observation, rice varieties having two times soaking periods (N3, N4) plant height decreased compared to one time immersion (N1, N2) (Table 3). Plant height of two rice varieties in the same immersion conditions was not significant for each fertilizer treatment, but tended to differ significantly between the immersion treatments. Treatment of IR 64 varieties which given full dose N fertilization with immersion of 7-14 and 28-35 hst (V1N3) had the lowest plant height of 85.2 cm and the highest in treatment of IR 64 varieties which were given ½ dose N fertilizer at planting time and the rest was administered at 42 hst with 7-14 hst immersion (V1N2), which was 108.3 cm and the plant height in this treatment showed no significant difference with non-immersion treatment (V1N0).

TABLE 1. Analysis results of soil properties before treatment

Analyses	Unit	Result	Status
pH H_2O		4.03	Very acid
C-Organic	%	1.82	Low
N-Total	%	0.17	Low
P-Bray I	ppm	13.65	Low
K-dd	me.$100g^{-1}$	0.26	Low
Na	me.$100g^{-1}$	0.22	Low
Ca	me.$100g^{-1}$	1.30	Very low
Mg	me.$100g^{-1}$	0.25	Very low
CEC	me.$100g^{-1}$	13.08	Low
Al-dd	me.$100g^{-1}$	1.00	Very low

Source: Soil Science Laboratory, Faculty of Agriculture, Unsri, 2015

3.4 *Number of Productive Tillers.* The number of productive tillers decreased in the rice varieties with two times immersion (N3, N4) compared to one immersion (N1, N2) (Table 3). Two rice varieties experiencing the same immersion conditions resulted in a number of no significant difference productive tillers for each fertilization treatment, but significantly different for the immersion treatment. Treatment of IR 64 varieties was given full dose of N fertilization with immersion of 7-14 and 28-35 hst (V1N3) had the lowest number of productive tillers, ie 13.2 tillers and highest number of tillers in the treatment of Inpara 5 was given ½ dose N fertilizer at planting time, and the rest was given at 42 hst with immersion of 7-14 hst (V2N2), which was 30.8 tillers, besides the number of productive tillers in this treatment showed no significant difference with treatment without immersion (V2N0).

3.5 *Plant Dry Matter Weight.* Plant dry matter weight was decreased in rice varieties with two times immersion (N3, N4) compared to one immersion (N1, N2) (Fig.1). Two rice varieties experiencing the same immersion conditions resulting in different dry weight of plants were not significant for each fertilization treatment, but differed significantly for immersion treatment. Treatment of IR 64 varieties given full dose N fertilization with immersion of 7-14 and 28-35 hst (V1N3) had lowest dry weight plant, i.e. 37.5 g / clump and highest dry weight in treatment Inpara 5 which was given ½ fertilizer Dose N at planting time and the rest was administered at 42 hst with immersion of 7-14 hst (V1N2), which was 117,5 g / clump, besides the amount of dry weight of plant in this treatment showed no significant difference with non-immersion treatment (V2N0).

TABLE 2. Percentage of survive plant (%) of two rice varieties and fertilizing treatment in condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR 64	100.0 b	100.0 b	100.0 b	66.7 a	83.3 ab
Inpara 5	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b

Notes: N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Number followed by the same characters are not significantly different at Least Significantly Different or $LSD_{0.05}$: 26.4

TABLE 3. Plant height (cm) at 42 days after planting of two rice varieties and fertilizing treatment at condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR64	107.0 ab	104.2 ab	108.3 b	85.2 a	99.3 ab
Inpara 5	109.1 ab	103.5 ab	107.5 ab	90.7 ab	101.0 ab

Notes : N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Numbers followed by the same characters are not significantly different at Least Significantly Different or LSD $_{0.05}$: 22.8

TABLE 4. Productive tiller numbers of two rice varieties and fertilizing treatment at condition of dirty water submergence stress.

Treatment	N0	N1	N2	N3	N4
IR64	26.0 c	25.2 bc	25.7 c	13.2 a	15.8 a
Inpara 5	27.7 c	26.7 c	30.8 c	16.7 a	18.7 ab

Notes : N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Number which followed by the same characters are not significantly different at Least Significantly Different or LSD $_{0.05}$: 7.0

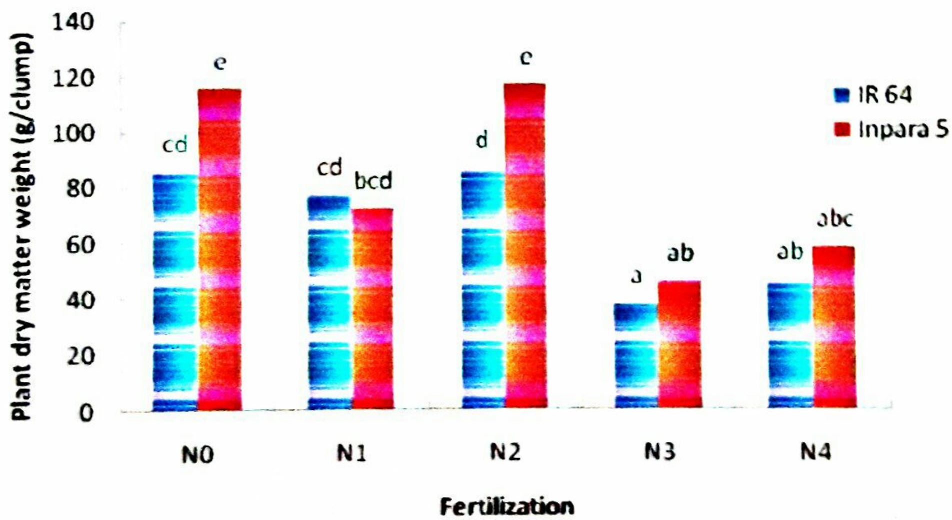


FIGURE 1. Plant dry matter weight at the end of research for two rice varieties and fertilizing treatment at condition of dirty water submergence stress. N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Number which followed by the same characters are not significantly different at Least Significantly Different or LSD $_{0.05}$: 27.9

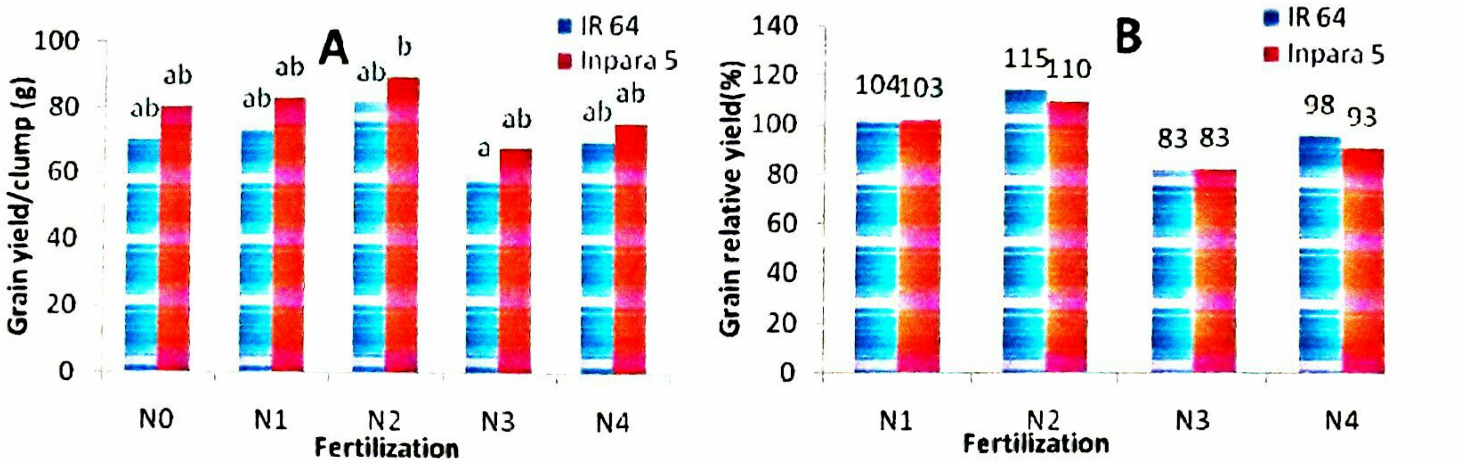


FIGURE 2. Fertilizing treatment effect for two rice varieties on grain yield (A) and relative grain yield (B) at condition of dirty water submergence stress. N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting. Number which followed by the same characters are not significantly different at Least Significantly Different or $LSD_{0.05}$: 28.7

TABLE 5. The fertilizing effect for two rice varieties on several yield components at condition of dirty water submergence stress

Treatment	Inpara 5			IR64		
	1	2	3	1	2	3
N0	130.8	93.0	2.39	128.5	91.0	2.49
N1	123.2	90.1	2.37	118.7	91.7	2.38
N2	128.9	93.2	2.36	129.7	92.6	2.42
N3	101.3	89.5	2.32	110.8	89.2	2.37
N4	112.3	91.8	2.44	122.1	91.1	2.41

Remarks: **1**: The number of grains per panicle (grains), **2**: Percentage of grain pithy (%), **3**: grain weight of 100 grains (g). N0 = without submergence, i.e. all N fertilizer was given during planting; N1 = submergence during 7-14 days after planting and N fertilizer was given during planting; N2 = submergence during 7-14 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting; N3 = submergence during 7-14 and 28-35 days after planting in which all N fertilizer dose was given during planting; N4 = submergence during 7-14 and 28-35 days after planting and ½ dose of N fertilizer was given during planting and the rest was given at 42 days after planting.

3.6. *Yield and Yield Components.* Arrangement of nitrogen fertilizer suppply affects the yield and component of grain yield per clump. Results and components of grain yield per clump were decreased in rice varieties with two times immersion (N3, N4) compared to one immersion (N1, N2) (Fig 2 and Table 5). Treatment of IR 64 varieties given full dose N fertilization with immersion of 7-14 and 28-35 hst (V1N3) had the lowest grain yield, ie 58.3 g / clump and highest grain yield on treatment Inpara 5 which was given ½ dose N fertilizer at planting time and the rest was given at 42 hst with immersion of 7-14 hst (V1N2), which was 88.6 g / clump, besides the grain yield on this treatment also showed different not significant with non-immersion treatment (V2N0).

Furthermore there is a very strong relationship pattern between grain yield per clump with dry weight of plant per clump, with the equation Y = 55,137 + 0,259X: R2 = 0,817 * (Figure 2). The higher the dry weight of the plant, the higher the yield of grain obtained.

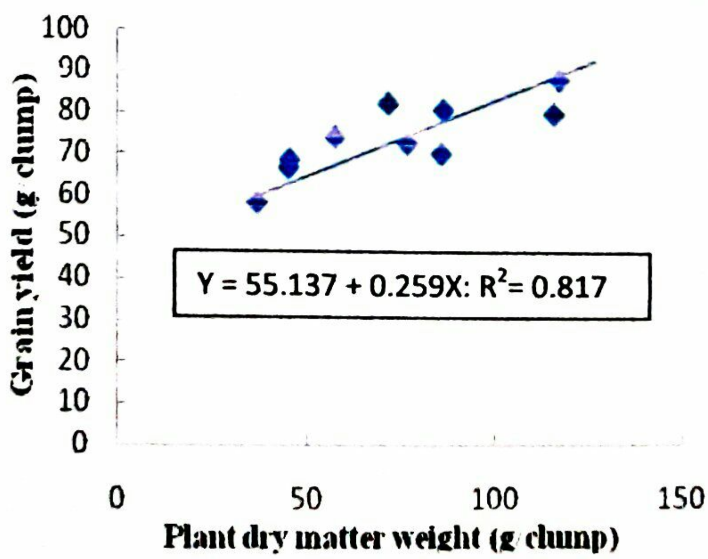


Figure 3. Relationship pattern between plant dry matter weight and grain yield.

4. Discussion

Analysis results of soil chemical properties prior to treatment (Table 1) showed that soil used in this research were lowland swamp soil with very acid reaction, low C-organic content and low total-N content. Low availability of phosphorus nutrient and low K-dd in this soil showed that effort of fertilizer application could overcome low nutrients availability as well as could increase rice crop yield.

The immersion stress has an effect on the tolerance, growth and yield of grain per clump of rice plants, as seen from the changes of life plant percentage, plant height, number of productive tillers, dry weight of plant and yield also some component of yield.

Crop tolerance is the ability of plants to avoid or reduce damage to crops the presence of soaking stress so as to grow and produce as in plants that do not experience the immersion stress. The longer and more frequent the rice plants experience soaking stress, the greater the damage that occurs in plants. The regulation of N fertilizer application statistically was not significant but it showed a tendency of increasing the percentage of live plants by 16.6 percent. According to [22], N fertilizer application was the proper measure to decrease negative effect of submergence stress on crop. Moreover, according to [14], recovery capacity is highly depends on plant capability to adapt quickly to certain condition after they experience flooding stress. In addition [2] stated that better recovery for rice plant which experienced submergence stress was indicated by faster new tillers emergence so that plant had relatively same tiller numbers or even higher tiller numbers than that of plant which not experienced submergence stress.

Management of N fertilizer application had effect on rice plant height. Rice variety which treated with half dose of N fertilizer during planting time and the rest was given at 42 days after planting, either received one time submergence or two times submergence, tend to have higher plant height than that of other fertilizing treatments. IR 64 rice variety even with one time submergence had higher plant height than without submergence treatment with magnitude of 107.5 cm. According to [18], management of N fertilizer application had effect on plant height and increment rate of plant height. In addition, [13] stated that plant height after flooding stress period was more affected by rice variety than by fertilization treatment. [1,6,17], also stated that that the increase in plant height becomes more noticeable with prolonged submergence

Rice varieties which experienced submergence stress treated with half dose of N fertilizer during planting time and the rest was given at 42 days after planting tend to have higher plant dry matter weight than that of other fertilizing treatments, even IR 64 and Inpara 5 varieties which experienced one time submergence tend to have higher plant dry matter weight than that of without submergence with maganitude of 86.7 g and 117.2 g, respectively. This was due to the fact that varieties treated with this fertilizing had higher plant height and higher tiller numbers than the other fertilizing treatments so that dry matter weight of these varieties were also high. According to [9], the weight increasing of plant dry is an indicator of growth and development of increasing plant. In addition [21] stated that post-submergence stem dry weight correlated positively and strongly with survival (r = 0,97).

Inpara 5 variety treated with half dose of N fertilizer during planting time and the rest was given at 42 days after planting showed higher grain yield than that of other treatments, either for one time submergence or two times submergence with grain yield of 88.6 g and 73.4 g, respectively. This was in accordance to high change of plant dry matter weight in this treatment resulting in high capability of plant to distribute assimilates into generative organ so that stem can produce more full grain which was shown by the change of several yield components on this treatment (Table 6). Study results from [11] showed that fertilization with half dose of Urea fertilizer during planting as well as Si and Zn in which the remainder was applied at 42 days after planting had produced the highest grain yield for all tested varieties for flooding period of 7 to 14 days after planting.

Moreover, there was very close relationship pattern between grain yield per clump and plants dry matter weight per clump expressed by equation of $Y = 55.137 + 0.259X$: $R^2 = 0.817^*$ (Figure 3). The higher the plants dry matter weight, the higher was the obtained grain yield. In addition, the research result of [24] reported that the grain yield also has very real relationship to the nitrogen content (r >0.73**).

5. Conclusions

The results showed that management of nitrogen fertilizer application had effect on rice growth and production which experienced dirty water submergence stress. Application of half dose of N fertilizer during planting time and the rest was given at 42 days after planting was the best treatment in term of rice growth and production. The longer the submergence period on rice variety, the bigger was the effect on rice growth and production.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

We especially wish to acknowledge the Ministry of Research, Technology and Higher Education that had already provided funding for this research through Competitive Research Grant (*Hibah Bersaing*) for fiscal year of 2015.

References

1. A. Anandan, G. Rajiv, A. Ramarao, and M. Prakash. "Internode Elongation Pattern and Differential Response of Rice Genotypes to Varying Level of Flood Water". *Functional Plant Biology*, vol. 39, pp. 137-145, 2012.
2. A.K. Makarim, E. Suhartatik, G.R. Pratiwi and Ikhwani. *Assembly of rice production technology on swamp land and flooding prone swamp (>15 days) for minimum productivity of 7 t ha-1* (in Indonesian), A Final Report of ROPP DIPA 2009. Indonesian Rice Research Institute. Indonesian Agricultural Research and Development, 2009.
3. A. M. Ismail, G. Vergara and D.J. Mackill. *Towards Enhanced and Sustained Rice Productivity in Flood-Prone Areas of South and Southeast Asia*, The 3rd National Seminar on Rice Day, Indonesian Rice Research Institute, Sukamandi 22-24 July 2008, 2008.
4. A.M. Ismail , U. Singh, S. Singh, M.H. Dar, and D.J. Mackill. "The contribution of submergence-tolerant (Sub1) rice varieties to food security in flood-prone rainfed lowland areas in Asia ". *Field Crops Research*, vol. 152, pp. 83–93, 2013.
5. Badan Perencanaan Pembangunan Nasional. *Indonesia Climate Change Sectoral Roadmap (ICCSR) of Agrcultural Sector*, http://bappenas.go.id, 2010.
6. B. Wang, Y.J. Zhou, Y.Z. Xu, G. Chen, Q.F. Hu, and W.G. Wu. "Effect Effects of Waterlogging Stress on Growth and Yield of Middle Season Rice at the Tillering Stage". *China Rice*, vol. 20, pp. 68–75, 2014.
7. C. Aydinalpn, M.S. Cresser. "The effect of global climate change on agriculture". *American-Eurasian J. Agric. Environ. Sci.*, vol. 3, pp. 672-676, 2008.
8. D.J. Mackill, A.M. Ismail, U.S. Singh, R.V. Labios, and T.R. Paris. "Development and rapid adoption of submergence-tolerant (Sub1) rice varieties". *Advances in Agronomy*, vol. 115, pp. 299–352, 2012.
9. E. Mungara, D. Indradewa and R. Rogomulyo. "Analysis of Growth and Rice Yields (Oryza sativa L.) Conventional, Organic Transitional and Organic Farming System" (in Indonesia with an abstract in English). *Jurnal Vegetalika*, vol. 2, no. 3, pp. 1-12, 2013.
10. E.M. Septiningsih, A.M. Pamplona, D.L. Sanches, C.N. Neeraja, G.V. Vergara, S. Heuer, A.M. Ismail and D.J. Mackill. " Development of Submergence-Tolerant Rice Cultivars: The Sub1 Locus and Beyond". *Ann. Bot.*, vol. 103, no. 2, pp. 151-160, 2009.
11. Gribaldi. *Agronomical Treatment to Increase Rice Crop's Tenacity and Recovery Toward Submergence Stress*, Doctoral Dissertation, Postgraduate School Program, Faculty of Agriculture, Sriwijaya University, Palembang, 2013.
12. Gribaldi, R.A. Suwignyo, M. Hasmeda and R. Hayati. "The Arrangement of Nitrogen Fertilizer Application to Increase The Rice Plant Tolerance and Recovery to The Submerged Stress" (in Indonesian with an abstract in English). *Jurnal Lahan Suboptimal*, vol. 2, no. 2, pp.151-158, 2013.
13. ____." The Effect of Fertilization on Morphophysiological Changes of Two Rice Varieties Under Submergence Stress" (in Indonesian with an abstract in English). *Jurnal Agronomi Indonesia*, vol. 42, no.1, pp.17-23, 2014.
14. ____. "Fertilization Strategy to Increase Rice Growth and Production Under Two Flooding Condition on Two Lowland Swamp Types". *Int. J. Agrivita*, vol. 38, no. 1, pp. 64-72, 2016.
15. Ikhwani. " Resistency of Submergence Tolerant Rice Variety and Its Response to Fertilizers" (in Indonesia with an abstract in English). *Jurnal Lahan Suboptimal*, vol. 2, no. 1, pp. 1-13, 2013.
16. IRRI and The Research and Development Council of Food Crops. *Submergence Tolerant Rice*. Food Crops Research and Development Center, 2009.
17. M.B. Jackson. "Ethylene promoted elongation: an adaptation to submergence stress". *Annals of Botany*, vol. 101, pp. 229–248, 2008.
18. R.A. Suwignyo, F. Zulvica and Hendryansyah. *Technological Adaptation for Rice Production at Lowland Swamp Area: The Effort to Prevent the Negative Effect of Rice Crop Flooding through Regulation of Nitrogen Fertilizer Application*, The 3rd National Seminar on Rice Day, Indonesian Rice Research Institute, Sukamandi 22-24 July 2008, 2008a.
19. R.A. Suwignyo, F. Zulvica and L. Hakim. *The Response of Several Rice Varieties to Nitrogen Treatment in Seedling and Silica Application through Coal Ash Residue*, The 3rd. National Seminar on Rice Day, Indonesian Rice Research Institute, Sukamandi 22-24 July 2008 , 2008b.
20. R.A. Suwignyo, A. Wijaya, H. Sihombing and Gribaldi. "Modification of Nutrients Application to Improve Rice Seeds Vigor in Submergence Condition" (in Indonesia with an abstract in English). *Jurnal Lahan Suboptimal*, vol. 1, no. 1, pp. 1-11, 2012.
21. S. Singh, D.J. Mackill, and A.M. Ismail. "Physiological Basis of Tolerance to Complete Submergence in Rice Involves Genetic Factors

in Addition to *Sub1* Gene". *oB Plant*, vol.6, doi:10.1093/aobpla/plu060, 2014.
22. S.T. Reed, and G.G. Gordon. " Nitrogen Fertilization Effect on Recovery of Bush Beans from Flooding". *Int. J. Veg. Sci.*, vol. 14, no. 3, pp. 256-272, 2008.
23. U.S. Singh, M.H. Dar, S. Singh, N.W. Zaidi, M.A. Bari, D.J. Mackill, B.C.Y. Collard, V.N. Singh, J.P. Singh, J.N. Reddy, R.K. Singh, and A.M. Ismail. " Field performance, dissemination, impact and tracking of submergence tolerant (Sub1) rice varieties in South Asia". *SABRAO Journal of Breeding and Genetics*, vol. 45, pp. 112–131, 2013.
24. Y. Zhang, Z. Wang, L. Li, Q. Zhou, Y. Xiao and X. Wei. "Short-Term Complete Submergence of Rice at the Tillering Stage Increases Yield". *PloS ONE*, vol. 10, no. 5, e0127982, 2015.

Judul **9734036: Galley Proof Corrections**

Dari: sahl.abdelrahman@hindawi.com
Kepada: gribaldi64@yahoo.co.id
Cc: lelinurlaili66@gmail.com; ekadanial20@gmail.com; nurmaladewitjekdin@gmail.com; rujito62@yahoo.com; firnafpubr@gmail.com
Tanggal: Minggu, 9 Juli 2017 23.38.15 WIB

Dear Dr. Gribaldi,

This is to confirm the receipt of the third galley proof corrections of Research Article 9734036 titled "Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress,".

Thank you for your cooperation.

Best regards,

--
****
Sahl abdelrahman
Editorial Office
Hindawi
https://www.hindawi.com
****

Your article has been published

Dari: Sahl abdelrahman (sahl.abdelrahman@hindawi.com)

Kepada: gribaldi64@yahoo.co.id

Tanggal: Selasa, 11 Juli 2017 14.16 GMT+7

Dear Dr. Gribaldi,

I am pleased to let you know that your article has been published in its final form in "International Journal of Agronomy."

Gribaldi Gribaldi, "Modified Application of Nitrogen Fertilizer for Increasing Rice Variety Tolerance toward Submergence Stress," International Journal of Agronomy, vol. 2017, Article ID 9734036, 6 pages, 2017. doi:10.1155/2017/9734036.

You can access this article from the Table of Contents of Volume 2017, which is located at the following link:

https://www.hindawi.com/journals/ija/contents/

Alternatively, you can access your article directly at the following location:

https://www.hindawi.com/journals/ija/2017/9734036/

"International Journal of Agronomy" is an open access journal, meaning that the full-text of all published articles is made freely available on the journal's website with no subscription or registration barriers.

Best regards,

Sahl abdelrahman
International Journal of Agronomy
Hindawi
https://www.hindawi.com/

Hindawi

Author Activities

MS Number	Title & Authors	Additional Files	Status	Article Processing Charges
9734036.v2 (Research Article)	Modified Application of Nitrogen Fertilizer to Increase Rice Variety Tolerance Toward Submergence Stress Gribaldi Gribaldi, Nurlaili Nurlaili, Nurmala Dewi, Ekawati Danial, Firnawati Sakalena, and Rujito Agus Suwignyo	Reply to review reports	Published	Paid Invoice