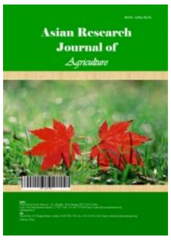



*Asian Research Journal of Agriculture*

***15(4): 156-160, 2022; Article no.ARJA.92976***
***ISSN: 2456-561X***

# The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer

**Joko Priyono [a*] and Anak Agung Ketut Sudharmawan [b]**

*[a] Department of Soil Science, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia.*
*[b] Department of Agroecotechnology, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia.*

***Authors' contributions***

*This work was carried out in collaboration between both authors. Author JP designed the study, technical aspects of seed coating, constructs the outline and wrote the first draft of the manuscripts. Author AAKS performed the statistical analysis and managed the literature searches for seed treatments. Both authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/ARJA/2022/v15i4366

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/92976

***Original Research Article***

***Received 13 August 2022***
***Accepted 18 October 2022***
***Published 20 October 2022***

## ABSTRACT

Seed coating with silicate rock-basis organomineral fertilizer (OMF) was proposed as an appropriate method to improve the productivity and profitability of rice farming. This research aimed to evaluate the growth and yield components of rice grown from coated seeds with N-enriched OMF. The coated seeds of two rice varieties, i.e., Trisakti (T) and Nutri Zinc (NZ) were tested in separate experimental sets. A randomized block design was applied for each experiment with the treatment consisting of non-coated seed (NCS), coated seeds containing 4.5% N (CS-1), 7.8% N (CS-2), and 9.0% N (CS-3) in 3 blocks. The coating material of OMF was a mixture of 90% basaltic rock and 10% rock phosphate, enriched with N accordingly to the treatment; and the weight ratio of seed to OMF was about 1:16. The coated seeds were planted directly to the ground (without sowing and transplanting steps), and only NCS was fertilized with NPK (15:15:15) equivalent to 300 kg. $ha^{-1}$. Results reveal that there was no significant difference in growth components (number of tillers and the weight of top-biomass) and quality of rice grains (weight of 1,000 grains) for the plants of coated and non-coated seeds. Enriching OMF with N up to 9% consistently improved the total yield of rice. Therefore, seed coating with OMF containing about 9% N was an appropriate method to optimize rice yield.

**Corresponding author: E-mail: jokotanahunram@gmail.com;*

*Keywords: Organomineral fertilizer; coating materials; seed coating; silicate rock fertilizer.*

## 1. INTRODUCTION

Seed industries have applied seed coating technology for decades aimed mainly to improve the productivity and profitability of farming. Most of the seed coatings, however, were designed to protect the seeds from the attack of soil-borne pathogens [1]. Consequently, the used coating materials contained various pesticides including fungicides and rodenticides [2,3,4], with supplementary plant nutrients [5], or zeolite [6]. Because exposing toxic pesticides to farming land can develop pest resistance and create various negative-ecological effects, the use of synthetic pesticides as the seed coating material should be avoided [7]. This is a major challenge for seed industries to develop coated seeds with more environmentally friendly materials.

Referring to the above case, we developed the coated seed of rice with local abundance and environmentally friendly materials, which was silicate rock-based-organomineral fertilizer (OMF), by applying different approach. Improving the productivity and profitability of farming was not by protecting the seeds or plants from the attack of pests and pathogens, but by maximizing the healthiness and resistance of plants to biotic and abiotic stresses using OMF. Practically, the plants were supplied with proportional essential and functional (Si) nutrients in form of OMF.

The components of OMF were mainly the finely ground basaltic and some phosphatic rocks, enriched with nitrogen substances. The OMF was designed as the main source of all plant-essential nutrients to support the optimum plant growth and yield and supply a functional nutrient of silicate (Si) to maximize the resistance of plants to biotic and abiotic stresses [8,9,10] without additional fertilizer. In addition, the OMF may also act as a remediating agent for disordered plant-growing media such as acidic [11] or salt-affected [12] soils.

Rice is a non-legume plant requiring a large amount of nitrogen (N) for optimum growth [13]. On the other hand, enriching the coating material with a high concentration of N fertilizers (e.g., urea) may create a technical problem in the coating process. It was because covering the seeds with materials containing a high concentration of N may toxify and stop the coated seed germination. In addition, the thickness of coated material may limit oxygen availability for the seed-embryonic tissue [14] delaying the germination process. Thus, the appropriate concentration of N as well as the thickness and suitable procedure of coating process must be found.

Results of a greenhouse assessment for the performance of the coated seeds of rice with OMF [15] showed that adding N to the coating material up to 2.5% was not sufficient to gain optimum growth and yield. Following up on that finding, this present research was intended to find out an appropriate method of adding enough N to the coating material (OMF), so that the plants from the coated seeds grow and yield optimally without additional N fertilizer.

The main objective of this research was to find out the most suitable amount of N added to the coating material (OMF), by evaluating the growth and yield components of the OMF-coated seeds compared to those of the non-coated seeds.

## 2. MATERIALS AND METHODS

### 2.1 Coating Materials and Process

The coating material of OMF and its chemical composition were like that used in the previous research [15]. The OMF consisted of basaltic rocks (90%) and rock phosphate (10%). Those rocks were mixed and finely ground with a horizontal-ball mill machine for 30 minutes producing very fine particles having a median diameter ($D_{50}$) of 22 μm. Three types of coated seeds were prepared with different concentrations of N in the coating material (see Table 1). The binding solution for the first layer was Tapioca starch solution (1%), and for the second layer was urea + Orrin. Besides binding material, Orrin was functioned also as a supplementary nutrient source and a converting agent of urea ($(NH_2)_2CO$) to $NH_4^+$ limiting volatilization of N during the coating process. The rice seeds of Trisakti (T) and Nutri Zinc (ZN) varieties were used in this experiment.

**Table 1. The composition of seed coating material used in this experiment**

| Type of Coated Seed | Seeds (g) | OMF (g) | Binding solution | |
|---|---|---|---|---|
| | | | 1st layer | 2nd layer |
| CS-1 | 250 | 4,000 | Starch sol. (1%) | 50 g urea + 150 mL Orrin*) |
| CS-2 | 250 | 4,000 | Starch sol. (1%) | 75 g urea + 150 mL Orrin |
| CS-3 | 250 | 4,000 | Starch sol. (1%) | 100 g urea + 150 mL Orrin |

**) The trademark of a liquid-silicate rock fertilizer with the matrix solution of citric acid, pH 3.5*

The process of seed coating used a 150-L stainless steel rotary drum that was horizontally rotated at the speed of 80 - 100 rpm. The seeds (250 g) were coated with OMF in two layering steps by using the binding solutions described in Table 1. For the first coating layer, the third part (about 1,500 g) of OMF was applied step-by-step in sequence with spraying the starch solution to cover the seeds. The remaining OMF was applied to the seeds in the same method but using the binder of urea + Orrin. The coated seeds were dried with a hand dryer (< $40^o$ C) in the rotating drum for about 30 minutes, then were taken out from the drum, dried completely under sunray to reach constant moisture (< 10%), and stored in a closed container. Before planting, the produced coated seeds were tested for their germination rate in a growth chamber. Results of the test confirmed that the coated seeds used in this research were very good – germinated > 95%.

## 2.2 Experimental Setting

The experiment was conducted on an irrigated paddy soil classified as Oxyaquic Hapluderts in Keruak Village - Central Lombok Regency, Indonesia. The soil was clay textured (46% clay), having a low content of total C-organic (1.2%) and total N (0.02%); the Olsen-extractable $P_2O_5$ was 16 mg. $kg^{-1}$, the acidity was about neutral (pH 7.2); the cation exchange capacity of the soil was 36.2 cmol. $kg^{-1}$, and the exchangeable K, Ca, Mg, and Na respectively were 0.14, 32.4, 4.4, and 0.1 cmol. $kg^{-1}$.

The agronomic performances of the coated seeds of each variety were tested in separate experimental sets. A randomized block design was laid out for each experimental set with the treatment consisting of non-coated seed (NCS), CS-1, CS-2, and CS-3 in 3 blocks. The size of an experimental unit (plot) was 5 m x 5 m, and between plots were separated by a 50-cm borderline. The soil was mechanically cultivated by plugging, mudding, smoothing, and allowed to equilibrate for two days in a saturated condition. The seeds were planted directly onto the saturated ground without germination or transplanting steps. Five seeds were planted per planting point with a spacing of 25 cm x 25 cm. The water level in each plot was maintained at 1 – 5 cm over the soil surface accordingly to the growing stage of the plants. Only the non-NCS plants were fertilized with NPK (15:15:15) at the rate equivalent to 300 kg. $ha^{-1}$. Harvesting was done 110 days after planting.

## 2.3 Data and Statistical Analyses

The main collected data (parameters) were the number of productive tillers, the weight of top-dry biomass, and whole and 1,000 grains. The analysis of variance (ANOVA) was carried out for each set of data, and the parameters significantly affected by the treatment were further evaluated with the least significant difference (LSD) method at $\alpha = 0.05$.

# 3. RESULTS AND DISCUSSION

## 3.1 The Growth Components

The number of productive tillers per hill and the weight of top-dry biomass were presented in Table 2. In addition, it was observed that the coated seeds germinated 3 – 5 days later than the non-coated ones; and there was no indication of N-deficient symptoms of plant leaf (data are not shown in this paper).

Statistically, there were no significant differences in growth performance (number of productive tillers and weight of dry-top biomass) between rice plants from the non-coated and coated seeds, either for the Trisakti or Nutri Zinc varieties. As shown in Table 2, the number of productive tellers per plot was about 35, and the weight of dry-top biomass per plot was about 17.5 kg. Based on the plant growth data, it may be interpreted that the effect of seed coating with OMF on the growth components of rice was similar to that for the application of synthetic fertilizer (NPK 300 kg. $ha^{-1}$).

**Table 2. The number (mean ± Sdev) of tillers and weight of top-dry biomass for Trisakti and Nutri Zinc Varieties**

| Type of Seeds | Number of Productive Tillers per Hill*) | | Top-Dry Biomass ($kg.plot^{-1}$) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (34.3 ± 1.2) | (34.3 ± 1.0) | (17.7 ± 0.5) | (17.8 ± 1.5) |
| CS-1 | (36.1 ± 0.5) | (34.6 ± 1.0) | (18.0 ± 0.4) | (18.2 ± 0.4) |
| CS-2 | (35.1 ± 1.0) | (34.7 ± 0.7) | (18.6 ± 0.7) | (18.8 ± 0.4) |
| CS-3 | (37.6 ± 1.1) | (34.9 ± 0.7) | (18.7 ± 0.4) | (19.4 ± 0.3) |

*) *Average values from 20-randomly sub-sampled plant hills*

**Table 3. The weights (mean ± Sdev) of whole and 1,000 grains for Trisakti and Nutri Zinc Varieties**

| Type of Seeds | Weight of Whole Grains ($kg. plot^{-1}$)*) | | Weight of 1,000 Grains (g) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (14.42 ± 1.56) a | (14.22 ± 1.28) a | (28.59 ± 0.71) | (26.83 ± 0.62) |
| CS-1 | (13.72 ± 0.70) a | (14.17 ± 0.76) a | (28.17 ± 0.85) | (26.91 ± 1.01) |
| CS-2 | (15.74 ± 0.37) b | (15.38 ± 0.33) ab | (26.03 ± 1.34) | (27.09 ± 0.67) |
| CS-3 | (16.52 ± 0.48) c | (16.73 ± 0.64) b | (28.52 ± 0.96) | (26.52 ± 0.96) |
| $LSD_{\alpha=0.05}$ | 0.77 | 1.28 | - | - |

*) *The values followed by the same letters are not significantly different based on the analysis of* $LSD_{\alpha=0.05}$

### 3.2 Yield Components

The yield components, i.e., the weights of whole grains per plot of 25 $m^2$ and 1,000 grains, were presented in Table 3. Results of analysis of variance showed that the quantity of rice yield for non-coated seeds was significantly different from that for the coated seeds, but there was no significant effect of the different types of seeds on the quality of rice grain (weight of 1,000 grains).

As shown in that Table 3, the rice yields were consistently improved by the increases of N concentration in the coating material OMF; and the highest yields were gained by the plants of CS-3, which were about 16.6 kg. $plot^{-1}$ (equivalent to 6,640 kg. $ha^{-1}$). Based on the results, coating the rice seeds with OMF containing about 9% N was a suitable method to optimize production.

## 4. CONCLUSION

The growth components (number of tillers and weight of biomass) and grain quality (weight of 1,000 grains) of the rice plants grown from the non-coated seeds were similar to those for the coated seeds with the N-enriched OMF. On the other hand, adding N up to 9% to the coating material (OMF) improved the grain yield of rice plants from the coated seeds, and the seed coating method was a suitable method to optimize production. By planting the OMF-coated seeds, farmers may gain optimum yield without applying additional fertilizers.

## ACKNOWLEDGEMENTS

The authors thank The Directorate of Higher Education, The Ministry of Research, Technology and Higher Education, The Republic of Indonesia for its financial support for the research.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Hill HJ. Recent development of seed technology. J. New Seeds. 1999;1(1):105-112.
2. Hazra DK, Patanjali PK. Seed coating formulation technologies: an environmental biology friendly approaches for sustainable agriculture. Bioscience Methods. 2016; 7(5):1-10.
3. Arias-Rivas, B. Evaluation of seed coating treatment on maize (*Zea mays*) stands establishment and seed rot caused by

*Pythium* spp. at early planting season. Ph.D. Thesis. Iowa State University; 1994.
4. Castañedaa LMF, Genroa C, Roggiaa I, Bendera SS, Benderb RJ, Pereiraa CN. Innovative rice seed coating (*Oryza sativa*) with polymer nanofibres and microparticles using the electrospinning method. J. Res. Updates in Polymer Sci. 2014;3(1):33-39.
5. Samac DA, Schraber S, Barclay S. A mineral seed coating for control of seedling diseases of Alfalfa suitable for organic production systems. Plant Diseases. 2015; 99(5):614-619.
6. Reus HAM, Glas J. Seed coating composition. Patent WO 2010107312 A1; 2010
7. Sharma KK, Singh US, Sharma P, Kumar A, Sharma L. Seed treatments for sustainable agriculture – a review. J. Applied and Nat. Sci. 2015;7(1):521-539.
8. Epstein E. Silicon. Annu. Rev. Plant Physiol. Plant Mol. Biol. 1999;50:641–664.
9. Biel K, Matichenkov V, Fomina I. Role of silicon in plant defensive system. In: Keeping (Ed.). Silicon in agriculture conference, South Africa. 2008;28.
10. Etesami H, Jeong BR. Silicon (Si): Review and future prospects on the action mechanisms in alleviating biotic and abiotic stresses in plants. Ecotoxicol. Environ. Saf. 2018;147:881–896.
11. Priyono J, Gilkes RJ. Application of silicate rock fertilizers improves plant growth: A glasshouse assessment. Comm. Soil and Plant Anal. 2008;39:358–369.
12. Ali A, Basra SMA, Hussain S, Iqbal J, Bukhsa MAAH, Saewar M. Salt stress alleviation in field crops through nutritional supplementation of silicon. Pakistan J. Nutr. 2012;11(8):637-655.
13. Bennett WF. Plant nutrient utilization and diagnostic plant symptoms. In: Benett WF (Ed.). Nutrient deficiencies & toxicities in crop plants. APS Press, the American Phytopathological Society, St Paul Minnesota; 1993.
14. Gorim L, Asch F. Seed coating increases seed moisture uptake and restricts embryonic oxygen availability in germinating cereal seeds. Biology. 2017; 6(31):1–14.
15. Priyono J, Sudharmawan AAK. Seed coating with organomineral fertilizer, an alternative method to improve the efficiency of farming. Asian R. J. Agr. 2020;12(1):12-17.



*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*https://www.sdiarticle5.com/review-history/92976*

# Asian Research Journal of Agriculture

(https://journalarja.com/index.php/ARJA/index)



## Indexing

## Abstracting, Indexing, other related databases, catalogue, reference citation etc.

A dedicated journal indexing team is working to include all of our journals in reputed indexing services or journal evaluation services or catalogue or reference citations, etc. **Authors should cross-check the authenticity of claims of indexing before submitting to any publisher (including our journal). We strongly encourage authors to take 'informed decision' before submission of any manuscript. In order to help the authors to take 'informed decision', we are providing web-links/proofs beside most of our claims of indexing or journal evaluation services. In addition, authors should visit the official site of the indexing organization or journal evaluation services before submitting any manuscript. We hope scholarly communities will appreciate our efforts to maintain integrity and transparency.**

**1. Index Copernicus ICV: 93.77 (Proof:** http://bit.ly/index-copernicus-arja (https://bit.ly/index-copernicus-arja))

**2. CNKI (China)** (https://scholar.cnki.net/journal/index/SJDT2456561X0046)

**3. Publons (https://publons.com/wos-op/publisher/5994/sciencedomain-international)**

**4. Google Scholar**

**5. PKP | Index** (Proof: https://bit.ly/PKP-ARJA (https://bit.ly/PKP-ARJA))

**6. CrossRef** (https://doi.org/10.9734/ARJA (https://doi.org/10.9734/ARJA))

**7. Quality Open Access Market (QOAM) (https://www.qoam.eu/journals/60581?returnUrl=%2Fjournals%3FOpenAccess%3D%26InstitutionalDiscounts%3D%26NoFee%3D%26PlanS%3D%26Title%3DAsian%2BResearch%2BJournal%2Bof%2BAgriculture%26Issn%3D%26Publisher%3DSCIENCEDOMAIN%2BInternational)**

**8. JournalTOCS (Proof: https://bit.ly/JournalTOCS-ARJA (https://bit.ly/JournalTOCS-ARJA))**

**9. ScienceOpen (Proof: https://bit.ly/ScienceOpen-ARJA (https://bit.ly/ScienceOpen-ARJA))**

**10. Scite Index (2021):**
**Link:** https://scite.ai/journals/asian-research-journal-of-agriculture-dvKZy (https://scite.ai/journals/asian-research-journal-of-agriculture-dvKZy)

**11. Scilit (https://www.scilit.net/journal/2654940)**

**12. SHERPA/RoMEO (UK) (http://www.sherpa.ac.uk/romeo/index.php)**

**13. Journalseek (http://journalseek.net/)**

**14. Citefactor (https://www.citefactor.org/)**

**15. WorldCAT (https://www.worldcat.org/)**

**16. ResearchGate (https://www.researchgate.net/journal/Asian-Research-Journal-of-Agriculture-2456-561X)**

**17. ACADEMIA (https://www.academia.edu)**

**18. iSEEK (http://education.iseek.com/iseek/home.page)**

**19. Semanticscholar (https://www.semanticscholar.org/search?q=%22Asian%20Research%20Journal%20of%20Agriculture%22&sort=relevance)**

**20. RefSEEK (https://www.refseek.com/)**

**21. WorldWideScience (https://worldwidescience.org/)**

**22. Bielefeld Academic Search (https://www.base-search.net/)**

**23. AGRIS**

**24. HINARI**

**25. Analytical sciences digital library**

**26. CiteSeerX (https://citeseerx.ist.psu.edu)**

**27. INSPIRE-HEP (http://inspirehep.net/?ln=en)**

**28. Mendeley**

**29. OAIster**

**30. OpenSIGLE**

**31. Paperity**

**32. RePEc**

**33. SSRN**

**34. CORE (https://core.ac.uk/)**

**35. Baidu Scholar**

**36. Sparrho (https://www.sparrho.com/)**

---

Make a Submission (https://journalarja.com/index.php/ARJA/manuscript-submission)

**Information**

For Readers (https://journalarja.com

/index.php/ARJA/information/readers)
For Authors (https://journalarja.com/index.php/ARJA/information/authors)
For Librarians (https://journalarja.com/index.php/ARJA/information/librarians)

## Current Issue

ATOM 1.0 (https://journalarja.com/index.php/ARJA/gateway/plugin/WebFeedGatewayPlugin/atom)
RSS 2.0 (https://journalarja.com/index.php/ARJA/gateway/plugin/WebFeedGatewayPlugin/rss2)
RSS 1.0 (https://journalarja.com/index.php/ARJA/gateway/plugin/WebFeedGatewayPlugin/rss)

# Asian Research Journal of Agriculture


**English title:** Asian Research Journal of Agriculture
**ISSN:** 2456-561X (online)
**GICID:** *n/d*
**DOI:** 10.9734/ARJA
**Website:** http://journalarja.com/index.php/ARJA/
**Publisher:** SCIENCEDOMAIN international
**Country:** IN
**Language of publication:** EN

Indexed in the ICI Journals Master List 2021

ICV 2021: 93.77

Archival ratings

MSHE points: n/d



**Deposited publications: 291** › Full text: 46% | Abstract: 100% | Keywords: 100% | References: 55%

Issues and contents

Please contact with:

**The editorial office of the journal** (Comments, Requests, Information)

**Index Copernicus** (Submissions, Questions, Suggestions)

Journal description | Details | Scientific profile | Editorial office | Publisher | Metrics

ISSN: 2456-561X Journal DOI: http://dx.doi.org/10.9734/arja Peer-review model: Advanced OPEN peer review Digital Archiving: Journal Repository (JR), LOCKSS, CLOCKSS ________________________________________ Asian Research Journal of Agriculture (ISSN: 2456-561X) aims to publish high quality papers in field of agricultural science. This journal facilitates the research and wishes to publish papers as long as they are technically correct, scientifically motivated. The journal also encourages the submission of useful reports of negative results. This is a quality controlled, OPEN peer reviewed, open access INTERNATIONAL journal. Subject matters include all areas of agricultural science viz., agronomy, agricultural chemistry, entomology, plant pathology, agricultural genomics, biology, chemistry, earth science, genetics & plant breeding, stored products research, post harvest biology and technology, seed science, irrigation and drainage, plant physiology, soil classification, soil fertility, soil conservation, insect and pest control, animal husbandry, aquaculture, agricultural engineering, agricultural economics, agroecology, biotechnology, organic agriculture, biodynamic agriculture, agribusiness and other allied areas. Every issue will consist of a minimum of 5 papers. Each issue will be running and all officially accepted manuscripts will be immediately published online. The state-of-the-art running issue concept gives authors the benefit of 'Zero Waiting Time' for the officially accepted manuscripts to be published. This journal is an international journal and its scope is not confined by the boundary of any country or region. This is an open-access journal which means that all content is freely available without charge to the user or his/her institution. Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author. This is in accordance with the BOAI definition of open access.

# *Asian Research Journal of Agriculture*



**ISSN(s):** 2456-561X **Publisher:** Sciencedomain International **Open Access:** -

Asian Research Journal of Agriculture, a subscription journal published by Sciencedomain International has 338 publications in the scite database. These publications have received 389 citation statements of which 61 indicate supporting evidence, 5 indicate contrasting evidence, and 309 are mentioning.

**Total Articles**

338

338 total publication(s)

**Citation Types**

| | |
|---|---|
| Supporting | 61 |
| Mentioning | 309 |
| Contrasting | 5 |
| Total | 389 |

**Editorial Notices**

| | |
|---|---|
| Retractions | 0 |
| Withdrawals | 0 |
| Corrections | 0 |
| Errata | 0 |
| Expression of Concern | 0 |

**2022 scite Index**

N/A
5-year SI

N/A 2-year SI

N/A Lifetime SI

## Create an account to view the remaining information in this dashboard, including:

- Trends in the yearly scite Index for these publications
- List of authors who contributed to publications in this dashboard to help you find reviewers, collaborators, or thought-leaders
- Searchable, filterable table of publications along with their scite classification tallies
- Configurable alerts to stay be notified as new citations happen to these publications

- Advanced Search to find publications that support or contrast your research
- Citation reports and visualizations to easily see what publications are saying about each other
- Browser extension to see Smart Citations wherever you read research
- Automated reference checks to make sure you are citing reliable research in your manuscripts
- **7 day free preview of our premium features.**

Sign Up →

# Trusted by researchers and organizations around the world

**Over 165,000 students researchers, and industry experts use scite**

See what they're saying

Rockefeller University Press, thebmj, Karger, fsg, Wiley, IOP, Cambridge University Press, Europe PMC, Microbiology Society, Thieme, frontiers, AAAS, AMA, PNAS, american physiological society, arXiv, The University of Hong Kong, Singapore Management University, Cold Spring Harbor Laboratory, Wake Forest University, Stanford University, emerald publishing, UCLA, SPIE., SAGE

BUKTI KOMUNIKASI - PROSES PUBLIKASI JOURNAL

ARJA 92976, 2022

# The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer

**Joko Priyono[1*], Anak Agung Ketut Sudharmawan[2]**

[1]*Department of Soil Science, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia*
[2]*Department of Agroecotechnology, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia*

.

**ABSTRACT**

Seed coating with silicate rock-basis organomineral fertilizer (OMF) was proposed as an appropriate method to improve the productivity and profitability of rice farming. This research aimed to evaluate the growth and yield components of rice grown from coated seeds with N-enriched OMF. The coated seeds of two rice varieties, i.e., Trisakti (T) and Nutri Zinc (NZ) were tested in separate experimental sets. A randomized block design was applied for each experiment with the treatment consisting of non-coated seed (NCS), coated seeds containing 4.5 % N (CS-1), 7.8 % N (CS-2), and 9.0 % N (CS-3) in 3 blocks. The coating material of OMF was a mixture of 90 % basaltic rock and 10 % rock phosphate, enriched with N accordingly to the treatment; and the weight ratio of seed to OMF was about 1:16. The coated seeds were planted directly to the ground (without sowing and transplanting steps), and only NCS was fertilized with NPK (15:15:15) equivalent to 300 kg. ha$^{-}$. Results reveal that there was no significant difference in growth components (number of tillers and the weight of top-biomass) and quality of rice grains (weight of 1,000 grains) for the plants of coated and non-coated seeds. Enriching OMF with N up to 9 % consistently improved the total yield of rice. Therefore, seed coating with OMF containing about 9 % N was an appropriate method to optimize rice yield.

*Keywords: organomineral fertilizer; coating materials; seed coating; silicate rock fertilizer*

## 1. INTRODUCTION

Seed industries have applied seed coating technology for decades aimed mainly to improve the productivity and profitability of farming. Most of the seed coatings, however, were designed to protect the seeds from the attack of soil-borne pathogens [1]. Consequently, the used coating materials contained various pesticides including fungicides and rodenticides [2] [3], or with supplementary plant nutrients or/and zeolite [4]. Because exposing toxic pesticides to farming land can develop pest resistance and create various negative-ecological effects, the use of synthetic pesticides as the seed coating material should be avoided [5]. For this reason, we developed the coated seed of rice with local abundance and environmentally friendly materials, which was silicate rock-based-organomineral fertilizer (OMF).

* e-mail address: jokotanahunram@gmail.com

The components of OMF were mainly the finely ground basaltic and some phosphatic rocks, enriched with nitrogen substances. The coating materials were designed as the main source of nutrients to support the optimum growth and yield of the plant without additional fertilizer.

Rice is a non-legume plant requiring a large amount of nitrogen (N) for optimum growth [6]. On the other hand, enriching the coating material with a high concentration of N fertilizers (e.g., urea) may create a technical problem in the coating process. It was because covering the seeds with materials containing a high concentration of N may toxify and stop the coated seed germination. To deal with the case, the appropriate concentration of N and a suitable coating procedure must be found.

Results of a greenhouse assessment for the performance of the coated seeds of rice with OMF [7] showed that adding N to the coating material up to 2.5 % was not sufficient to gain optimum growth and yield. Following up on that finding, this present research was intended to find out an appropriate method of adding enough N to the coating material (OMF), so that the plants from the coated seeds grow and yield optimally without additional N fertilizer.

The main objective of this research was to find out the most suitable amount of N added to the coating material (OMF), by evaluating the growth and yield components of the OMF-coated seeds compared to those of the non-coated seeds.

## 2. MATERIALS AND METHOD

### 2.1. Coating Materials and Process

The coating material of OMF and its chemical composition were like that used in the previous research [7]. The OMF consisted of basaltic rocks (90 %) and rock phosphate (10 %). Those rocks were mixed and finely ground with a horizontal-ball mill machine for 30 minutes producing very fine particles having a median diameter ($D_{50}$) of 22 $\mu m$. Three types of coated seeds were prepared with different concentrations of N in the coating material. r (see Table 1). The binding solution for the first layer was Tapioca starch solution (1 %), and for the second layer was urea + Orrin. Besides binding material, Orrin was functioned also as a supplementary nutrient source and a converting agent of urea ($(NH_2)_2CO$) to $NH_4^+$ limiting volatilization of N during the coating process. The rice seeds of Trisakti (T) and Nutri Zinc (ZN) varieties were used in this experiment.

Table 1. The composition of seed coating material used in this experiment

| Type of Coated Seed | Seeds (g) | OMF (g) | Binding Solution | |
|---|---|---|---|---|
| | | | 1$^{st}$ layer | 2$^{nd}$ layer |
| CS-1 | 250 | 4,000 | starch sol. (1 %) | 50 g urea + 150 mL Orrin* |
| CS-2 | 250 | 4,000 | starch sol. (1 %) | 75 g urea + 150 mL Orrin |
| CS-3 | 250 | 4,000 | starch sol. (1 %) | 100 g urea + 150 mL Orrin |

* The trademark of a liquid-silicate rock fertilizer with the matrix solution of citric acid, pH 3.5

The process of seed coating used a 150-L stainless steel rotary drum that was horizontally rotated at the speed of 80 - 100 rpm. The seeds (250 g) were coated with OMF in two layering steps by using the binding solutions described in Table 1. For the first coating layer, the third part (about 1,500 g) of OMF was applied step-by-step in sequence with spraying the starch solution to cover the seeds. The remaining OMF was applied to the seeds in the same method but using the binding solution of urea + Orrin. The coated seeds were dried with a hand dryer (< 40$^o$ C) in the rotating drum for about 30 minutes, then were taken out from the drum, dried

* e-mail address: jokotanahunram@gmail.com

completely under sunray to reach constant moisture (< 10 %), and stored in a closed container. Before planting, the produced coated seeds were tested for their germination rate in a growth chamber. Results of the test confirmed that the coated seeds used in this research were very good – germinated > 95 %.

### 2.2. Experimental Setting

The experiment was conducted on an irrigated paddy soil classified as Oxyaquic Hapluderts in Keruak Village - Central Lombok Regency, Indonesia. The soil was clay textured (46 % clay), having a low content of total C-organic (1.2 %) and total N (0.02 %); the Olsen-extractable $P_2O_5$ was 16 mg. kg$^{-}$, the acidity was about neutral (pH 7.2); the cation exchange capacity of the soil was 36.2 cmol. kg$^{-}$, and the exchangeable K, Ca, Mg, and Na respectively were 0.14, 32.4, 4.4, and 0.1 cmol. kg$^{-}$.

The agronomic performances of the coated seeds of each variety were tested in separate experimental sets. A randomized block design was laid out for each experimental set with the treatment consisting of non-coated seed (NCS), CS-1, CS-2, and CS-3 in 3 blocks. The size of an experimental unit (plot) was 5 m x 5 m, and between plots were separated by a 50-cm borderline. The soil was mechanically cultivated by plugging, mudding, smoothing, and allowed to equilibrate for two days in a saturated condition. The seeds were planted directly onto the saturated ground without germination or transplanting steps. Five seeds were planted per planting point with a spacing of 25 cm x 25 cm. The water level in each plot was maintained at 1 – 5 cm over the soil surface accordingly to the growing stage of the plants. Only the non-NCS plants were fertilized with NPK (15:15:15) at the rate equivalent to 300 kg. ha$^{-}$. Harvesting was done 110 days after planting.

### 2.3. Data and Statistical Analyses

The main collected data (parameters) were the number of productive tillers, the weight of top-dry biomass, and whole and 1,000 grains. The analysis of variance (ANOVA) was carried out for each set of data, and the parameters significantly affected by the treatment were further evaluated with the least significant difference (LSD) method at $\alpha = 0.05$.

## 3. RESULTS AND DISCUSSION

### 3.1. The Growth Components

The number of productive tillers per hill and the weight of top-dry biomass were presented in Table 2. In addition, it was observed that the coated seeds germinated 3 – 5 days later than the non-coated ones; and there was no indication of N-deficient symptoms of plant leaf (data are not shown in this paper).

Table 2. The average number of tillers and weight of top-dry biomass for Trisakti and Nutri Zinc Varieties

| Type of Seeds | Number of Productive Tillers (per Hill) | | Top-Dry Biomass (kg.plot$^{-}$) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | 34 | 34 | 17.7 | 17.8 |
| CS-1 | 36 | 35 | 18.0 | 18.2 |
| CS-2 | 35 | 35 | 18.6 | 18.8 |
| CS-3 | 38 | 35 | 18.7 | 19.4 |

* e-mail address: jokotanahunram@gmail.com

Statistically, there were no significant differences in growth performance (number of productive tillers and weight of dry-top biomass) between rice plants from the non-coated and coated seeds, either for the Trisakti or Nutri Zinc varieties. As shown in Table 2, the number of productive tellers per plot was about 35, and the weight of dry-top biomass per plot was about 17.5 kg. Based on the plant growth data, it may be interpreted that the effect of seed coating with OMF on the growth components of rice was similar to that for the application of synthetic fertilizer (NPK 300 kg. ha$^{-}$).

### 3.2. Yield Components

The yield components, i.e., the weights of whole grains per plot of 25 m$^2$ and 1,000 grains, were presented in Table 3. Results of analysis of variance showed that the quantity of rice yield for non-coated seeds was significantly different from that for the coated seeds, but there was no significant effect of the different types of seeds on the quality of rice grain (weight of 1,000 grains).

Table 3. The weights of whole and 1,000 grains for Trisakti and Nutri Zinc Varieties

| Type of Seeds | Weight of Whole Grains (kg. plot$^{-}$) | | Weight of 1,000 Grains (g) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | 14.42 a | 14.22 a | 28.63 | 26.83 |
| CS-1 | 13.72 a | 14.17 a | 28.17 | 26.91 |
| CS-2 | 15.74 b | 15.38 ab | 26.03 | 27.09 |
| CS-3 | 16.52 c | 16.73 b | 28.24 | 26.52 |
| $LSD_{\alpha=0.05}$ | 0.77 | 1.28 | - | - |

As shown in that Table 3, the rice yields were consistently improved by the increases of N concentration in the coating material OMF; and the highest yields were gained by the plants of SC-3, which were about 16.6 kg. plot$^{-}$ (equivalent to 6,640 kg. ha$^{-}$). Based on the results, coating the rice seeds with OMF containing about 9 % N was a suitable method to optimize production.

## 4. CONCLUSION

The growth components (number of tillers and weight of biomass) and grain quality (weight of 1,000 grains) of the rice plants grown from the non-coated seeds were similar to those for the coated seeds with the N-enriched OMF. On the other hand, adding N up to 9 % to the coating material (OMF) improved the grain yield of rice plants from the coated seeds, and the seed coating method was a suitable method to optimize production. By planting the OMF-coated seeds, farmers may gain optimum yield without applying additional fertilizers.

## ACKNOWLEDGEMENTS

The authors thank The Directorate of Higher Education, The Ministry of Research, Technology and Higher Education, The Republic of Indonesia for its financial support for the research

* e-mail address: jokotanahunram@gmail.com

## COMPETING INTERESTS

THE AUTHORS HAVE DECLARED THAT NO COMPETING interests exist.

## AUTHORS' CONTRIBUTIONS

THIS WORK WAS CARRIED OUT IN COLLABORATION BETWEEN BOTH AUTHORS. AUTHOR JP DESIGNED THE STUDY, AND TECHNICAL ASPECTS OF SEED COATING, CONSTRUCTS THE OUTLINE, AND WROTE THE FIRST DRAFT OF THE MANUSCRIPTS. AUTHOR AAKS PERFORMED THE STATISTICAL ANALYSIS, AND MANAGED THE LITERATURE SEARCHES FOR SEED TREATMENTS. BOTH AUTHORS READ AND APPROVED THE FINAL MANUSCRIPT.

## REFERENCES


1. Hill, H.J. Recent development of seed technology. J. New Seeds. 1999; 1(1):105-112.

2. Arias-Rivas, B. Evaluation of seed coating treatment on maize (Zea mays) stands establishment and seed rot caused by Pythium spp. at early planting season. Ph.D. Thesis. Iowa State University. 1994.

3. Castañedaa, L.M.F., Genroa, C., Roggiaa, I., Bendera, S.S., Benderb, R.J. & Pereiraa, C.N. Innovative rice seed coating (Oryza Sativa) with polymer nanofibres and microparticles using the electrospinning method. J. Res. Updates in Polymer Sci. 2014; 3(1),33-39.

4. Samac, D.A., Schraber, S. & Barclay, S. A mineral seed coating for control of seedling diseases of Alfalfa suitable for organic production systems. Plant Diseases. 2015; 99(5), 614-619.

5. Sharma, K.K., Singh, U.S., Sharma, P., Kumar, A. & Sharma, L. Seed treatments for sustainable agriculture – a review. J. Applied and Nat. Sci. 2015; 7(1):521-539.

6. Bennett WF. Plant nutrient utilization and diagnostic plant symptoms. In: Benett WF (Ed.). Nutrient deficiencies & toxicities in crop plants. APS Press, The American Phytopathological Society, St Paul Minnesota; 1993.

7. Priyono J, Sudharmawan AAK. Seed Coating with Organomineral Fertilizer, an Alternative Method to Improve the Efficiency of Farming. Asian R. J. Agr. 2020; 12(1):12-17.


* e-mail address: jokotanahunram@gmail.com

## Review Form 1.6

| | |
|---|---|
| Journal Name: | **Asian Research Journal of Agriculture** |
| Manuscript Number: | **Ms_ARJA_92976** |
| Title of the Manuscript: | **The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer** |
| Type of the Article | **Original Research Article** |

### General guideline for Peer Review process:

This journal's peer review policy states that **NO** manuscript should be rejected only on the basis of '**lack of Novelty'**, provided the manuscript is scientifically robust and technically sound.
To know the complete guideline for Peer Review process, reviewers are requested to visit this link:

(https://www.journalarja.com/index.php/ARJA/editorial-policy )

**PART 1:** **Review Comments**

| | **Reviewer's comment** | **Author's comment** *(if agreed with reviewer, correct the manuscript and highlight that part in the manuscript. It is mandatory that authors should write his/her feedback here)* |
|---|---|---|
| **Compulsory** REVISION comments | | |
| **Minor** REVISION comments | Reviewer's comment<br>Dear Sir<br>Thank you for considering me as a reviewer for this publication in your journal<br><br>-The article is very interesting very original and very well written, however<br><br>-the author should add a graphical abstract to explain the experiment and results schematicly.<br>- in the results part; the author should add other parameters to justify this original results in fact these results are not enough.<br>-<br>- the references number are also not enough | - Since the data are simple, resulted from simple experimental design, I prefer to presented in table form rather than in schematic/graphical presentations.<br>- These results are not enough (?). I think that is something relative, depending on the objective of the research. So, I have no specific response. The presented data have been selected to meet the main objective of this research.<br>- Adding more references: I agree. Additional references are mainly related to the detailed explanation for the question of why using OMF that is different with the commonly used materials by seed industries.<br><br>Thank you. |
| **Optional/General** comments | | |

**PART 2:**

| | **Reviewer's comment** | **Author's comment** *(if agreed with reviewer, correct the manuscript and highlight that part in the manuscript. It is mandatory that authors should write his/her feedback here)* |
|---|---|---|
| **Are there ethical issues in this manuscript?** | *(If yes, Kindly please write down the ethical issues here in details)* | |

Reviewer Details:

| | |
|---|---|
| Name: | **Anonymous Reviewer, Reviewer preferred to be anonymous.** |
| Department, University & Country | |

## Review Form 1.6

| | |
|---|---|
| Journal Name: | **Asian Research Journal of Agriculture** |
| Manuscript Number: | **Ms_ARJA_92976** |
| Title of the Manuscript: | **The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer** |
| Type of the Article | **Original Research Article** |

### General guideline for Peer Review process:

This journal's peer review policy states that **NO** manuscript should be rejected only on the basis of '**lack of Novelty'**, provided the manuscript is scientifically robust and technically sound.
To know the complete guideline for Peer Review process, reviewers are requested to visit this link:

(https://www.journalarja.com/index.php/ARJA/editorial-policy )

**PART 1: Review Comments**

| | **Reviewer's comment** | **Author's comment** *(if agreed with reviewer, correct the manuscript and highlight that part in the manuscript. It is mandatory that authors should write his/her feedback here)* |
|---|---|---|
| **Compulsory** REVISION comments | The unit "cmol. kg-" should be rewrite to "cmol·kg$^{-1}$"<br><br>The unit "kg. plot-" should be rewrite to "kg·plot$^{-1}$"<br><br>Check your code "CS-3" and "SC-3", it should be written the same, if it has the same meaning. | Yes, I agree. Corrections were done in the revised paper.<br><br>Ok. It was a typo. |
| **Minor** REVISION comments | The results in Table 2 should be reported in a format of "mean ± sd" such as 34 ± 5 tiller/hill<br><br>More discussion should be written. The soil has low K, but why plant did not respond to K. | I agree<br><br>I think we agree that plant growth and yield are the results of a complex-confounding effect of all essential nutrients (and other environment components). I have no appropriate data to support further discussions which may not associable to the main objective of this research. |
| **Optional/General** comments | | Thank you for your review. |

**PART 2:**

| | **Reviewer's comment** | **Author's comment** *(if agreed with reviewer, correct the manuscript and highlight* |
|---|---|---|

| | | |
|---|---|---|
| | | *that part in the manuscript. It is mandatory that authors should write his/her feedback here)* |
| **Are there ethical issues in this manuscript?** | *(If yes, Kindly please write down the ethical issues here in details)* | |

Reviewer Details:

| | |
|---|---|
| Name: | **Anonymous Reviewer, Reviewer preferred to be anonymous.** |
| Department, University & Country | |

## *Original Research Article*

# The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer

.


## ABSTRACT

Seed coating with silicate rock-basis organomineral fertilizer (OMF) was proposed as an appropriate method to improve the productivity and profitability of rice farming. This research aimed to evaluate the growth and yield components of rice grown from coated seeds with N-enriched OMF. The coated seeds of two rice varieties, i.e., Trisakti (T) and Nutri Zinc (NZ) were tested in separate experimental sets. A randomized block design was applied for each experiment with the treatment consisting of non-coated seed (NCS), coated seeds containing 4.5 % N (CS-1), 7.8 % N (CS-2), and 9.0 % N (CS-3) in 3 blocks. The coating material of OMF was a mixture of 90 % basaltic rock and 10 % rock phosphate, enriched with N accordingly to the treatment; and the weight ratio of seed to OMF was about 1:16. The coated seeds were planted directly to the ground (without sowing and transplanting steps), and only NCS was fertilized with NPK (15:15:15) equivalent to 300 kg. ha$^{-1}$. Results reveal that there was no significant difference in growth components (number of tillers and the weight of top-biomass) and quality of rice grains (weight of 1,000 grains) for the plants of coated and non-coated seeds. Enriching OMF with N up to 9 % consistently improved the total yield of rice. Therefore, seed coating with OMF containing about 9 % N was an appropriate method to optimize rice yield.



*Keywords: organomineral fertilizer; coating materials; seed coating; silicate rock fertilizer*


## 1. INTRODUCTION

Seed industries have applied seed coating technology for decades aimed mainly to improve the productivity and profitability of farming. Most of the seed coatings, however, were designed to protect the seeds from the attack of soil-borne pathogens [1]. Consequently, the used coating materials contained various pesticides including fungicides and rodenticides [2] [3] [4], with supplementary plant nutrients [5], or zeolite [6]. Because exposing toxic pesticides to farming land can develop pest resistance and create various negative-ecological effects, the use of synthetic pesticides as the seed coating material should be avoided [7]. This is a major challenge for seed industries to develop coated seeds with more environmentally friendly materials.

Referring to the above case, we developed the coated seed of rice with local abundance and environmentally friendly materials, which was silicate rock-based-organomineral fertilizer (OMF), by applying different approach. Improving the productivity and profitability of farming was not by protecting the seeds or plants from the attack of pests and pathogens, but by maximizing the healthiness and resistance of plants to biotic and abiotic stresses using OMF. Practically, the plants were supplied with proportional essential and functional (Si) nutrients in form of OMF.

The components of OMF were mainly the finely ground basaltic and some phosphatic rocks, enriched with nitrogen substances. The OMF was designed as the main source of all plant-essential nutrients to support the optimum plant growth and yield and supply a functional nutrient of silicate (Si) to maximize the resistance of plants to biotic and abiotic stresses [8] [9] without additional fertilizer. In addition, the OMF may also act as a remediating agent for disordered plant-growing media such as acidic [11] or salt-affected [12] soils.

Rice is a non-legume plant requiring a large amount of nitrogen (N) for optimum growth [13]. On the other hand, enriching the coating material with a high concentration of N fertilizers (e.g., urea) may create a technical problem in the coating process. It was because covering the seeds with materials containing a high concentration of N may toxify and stop the coated seed germination. In addition, the thickness of coated material may limit oxygen availability for the seed-embryonic tissue [14] delaying the germination process. Thus, the appropriate concentration of N as well as the thickness and suitable procedure of coating process must be found.

Results of a greenhouse assessment for the performance of the coated seeds of rice with OMF [15] showed that adding N to the coating material up to 2.5 % was not sufficient to gain optimum growth and yield. Following up on that finding, this present research was intended to find out an appropriate method of adding enough N to the coating material (OMF), so that the plants from the coated seeds grow and yield optimally without additional N fertilizer.

The main objective of this research was to find out the most suitable amount of N added to the coating material (OMF), by evaluating the growth and yield components of the OMF-coated seeds compared to those of the non-coated seeds.

## 2. MATERIALS AND METHOD

### 2.1. Coating Materials and Process

The coating material of OMF and its chemical composition were like that used in the previous research [15]. The OMF consisted of basaltic rocks (90 %) and rock phosphate (10 %). Those rocks were mixed and finely ground with a horizontal-ball mill machine for 30 minutes producing very fine particles having a median diameter ($D_{50}$) of 22 $\mu m$. Three types of coated seeds were prepared with different concentrations of N in the coating material (see Table 1). The binding solution for the first layer was Tapioca starch solution (1 %), and for the second layer was urea + Orrin. Besides binding material, Orrin was functioned also as a supplementary nutrient source and a converting agent of urea ($(NH_2)_2CO$) to $NH_4^+$ limiting volatilization of N during the coating process. The rice seeds of Trisakti (T) and Nutri Zinc (ZN) varieties were used in this experiment.

Table 1. The composition of seed coating material used in this experiment

| Type of Coated Seed | Seeds (g) | OMF (g) | Binding Solution | |
|---|---|---|---|---|
| | | | 1st layer | 2nd layer |
| CS-1 | 250 | 4,000 | starch sol. (1 %) | 50 g urea + 150 mL Orrin*) |
| CS-2 | 250 | 4,000 | starch sol. (1 %) | 75 g urea + 150 mL Orrin |
| CS-3 | 250 | 4,000 | starch sol. (1 %) | 100 g urea + 150 mL Orrin |

*) The trademark of a liquid-silicate rock fertilizer with the matrix solution of citric acid, pH 3.5

The process of seed coating used a 150-L stainless steel rotary drum that was horizontally rotated at the speed of 80 - 100 rpm. The seeds (250 g) were coated with OMF in two layering steps by using the binding solutions described in Table 1. For the first coating layer, the third part (about 1,500 g) of OMF was applied step-by-step in sequence with spraying the starch solution to cover the seeds. The remaining OMF was applied to the seeds in the same method but using the binder of urea + Orrin. The coated seeds were dried with a hand dryer (< $40^{o}$ C) in the rotating drum for about 30 minutes, then were taken out from the drum, dried completely under sunray to reach constant moisture (< 10 %), and stored in a closed container. Before planting, the produced coated seeds were tested for their germination rate in a growth chamber. Results of the test confirmed that the coated seeds used in this research were very good – germinated > 95 %.

## 2.2. Experimental Setting

The experiment was conducted on an irrigated paddy soil classified as Oxyaquic Hapluderts in Keruak Village - Central Lombok Regency, Indonesia. The soil was clay textured (46 % clay), having a low content of total C-organic (1.2 %) and total N (0.02 %); the Olsen-extractable $P_2O_5$ was 16 mg. $kg^{-1}$, the acidity was about neutral (pH 7.2); the cation exchange capacity of the soil was 36.2 cmol. $kg^{-1}$, and the exchangeable K, Ca, Mg, and Na respectively were 0.14, 32.4, 4.4, and 0.1 cmol. $kg^{-1}$.

The agronomic performances of the coated seeds of each variety were tested in separate experimental sets. A randomized block design was laid out for each experimental set with the treatment consisting of non-coated seed (NCS), CS-1, CS-2, and CS-3 in 3 blocks. The size of an experimental unit (plot) was 5 m x 5 m, and between plots were separated by a 50-cm borderline. The soil was mechanically cultivated by plugging, mudding, smoothing, and allowed to equilibrate for two days in a saturated condition. The seeds were planted directly onto the saturated ground without germination or transplanting steps. Five seeds were planted per planting point with a spacing of 25 cm x 25 cm. The water level in each plot was maintained at 1 – 5 cm over the soil surface accordingly to the growing stage of the plants. Only the non-NCS plants were fertilized with NPK (15:15:15) at the rate equivalent to 300 kg. $ha^{-1}$. Harvesting was done 110 days after planting.

## 2.3. Data and Statistical Analyses

The main collected data (parameters) were the number of productive tillers, the weight of top-dry biomass, and whole and 1,000 grains. The analysis of variance (ANOVA) was carried out for each set of data, and the parameters significantly affected by the treatment were further evaluated with the least significant difference (LSD) method at $\alpha = 0.05$.

## 3. RESULTS AND DISCUSSION

## 3.1. The Growth Components

The number of productive tillers per hill and the weight of top-dry biomass were presented in Table 2. In addition, it was observed that the coated seeds germinated 3 – 5 days later than the non-coated ones; and there was no indication of N-deficient symptoms of plant leaf (data are not shown in this paper).

Statistically, there were no significant differences in growth performance (number of productive tillers and weight of dry-top biomass) between rice plants from the non-coated and coated seeds, either for the Trisakti or Nutri Zinc varieties. As shown in Table 2, the number of productive tellers per plot was about 35, and the weight of dry-top biomass per plot was about 17.5 kg. Based on the plant growth data, it may be interpreted that the effect of seed coating with OMF on the growth components of rice was similar to that for the application of synthetic fertilizer (NPK 300 kg. $ha^{-1}$).

Table 2. The number (mean ± Sdev) of tillers and weight of top-dry biomass for Trisakti and Nutri Zinc Varieties

| Type of Seeds | Number of Productive Tillers per Hill*) | | Top-Dry Biomass (kg.$plot^{-1}$) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (34.3 ± 1.2) | (34.3 ± 1.0) | (17.7 ± 0.5) | (17.8 ± 1.5) |
| CS-1 | (36.1 ± 0.5) | (34.6 ± 1.0) | (18.0 ± 0.4) | (18.2 ± 0.4) |
| CS-2 | (35.1 ± 1.0) | (34.7 ± 0.7) | (18.6 ± 0.7) | (18.8 ± 0.4) |
| CS-3 | (37.6 ± 1.1) | (34.9 ± 0.7) | (18.7 ± 0.4) | (19.4 ± 0.3) |

*) Average values from 20-randomly sub-sampled plant hills.

### 3.2. Yield Components

The yield components, i.e., the weights of whole grains per plot of 25 $m^2$ and 1,000 grains, were presented in Table 3. Results of analysis of variance showed that the quantity of rice yield for non-coated seeds was significantly different from that for the coated seeds, but there was no significant effect of the different types of seeds on the quality of rice grain (weight of 1,000 grains).

Table 3. The weights (mean ± Sdev) of whole and 1,000 grains for Trisakti and Nutri Zinc Varieties

| Type of Seeds | Weight of Whole Grains (kg. $plot^{-1}$)*) | | Weight of 1,000 Grains (g) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (14.42 ± 1.56) a | (14.22 ± 1.28) a | (28.59 ± 0.71) | (26.83 ± 0.62) |
| CS-1 | (13.72 ± 0.70) a | (14.17 ± 0.76) a | (28.17 ± 0.85) | (26.91 ± 1.01) |
| CS-2 | (15.74 ± 0.37) b | (15.38 ± 0.33) ab | (26.03 ± 1.34) | (27.09 ± 0.67) |
| CS-3 | (16.52 ± 0.48) c | (16.73 ± 0.64) b | (28.52 ± 0.96) | (26.52 ± 0.96) |
| $LSD_{\alpha=0.05}$ | 0.77 | 1.28 | - | - |

*) *The values followed by the same letters are not significantly different based on the analysis of* $LSD_{\alpha=0.05}$

As shown in that Table 3, the rice yields were consistently improved by the increases of N concentration in the coating material OMF; and the highest yields were gained by the plants of CS-3, which were about 16.6 kg. $plot^{-1}$ (equivalent to 6,640 kg. $ha^{-1}$). Based on the results, coating the rice seeds with OMF containing about 9 % N was a suitable method to optimize production.

## 4. CONCLUSION

The growth components (number of tillers and weight of biomass) and grain quality (weight of 1,000 grains) of the rice plants grown from the non-coated seeds were similar to those for the coated seeds with the N-enriched OMF. On the other hand, adding N up to 9 % to the coating material (OMF) improved the grain yield of rice plants from the coated seeds, and the seed coating method was a suitable method to optimize production. By planting the OMF-coated seeds, farmers may gain optimum yield without applying additional fertilizers.

## REFERENCES


1. Hill, HJ. Recent development of seed technology. J. New Seeds. 1999; 1(1),105-112.

2. Hazra, DK, Patanjali, PK. Seed coating formulation technologies: an environmental biology friendly approaches for sustainable agriculture. Bioscience Methods. 2016; 7(5), 1-10.

3. Arias-Rivas, B. Evaluation of seed coating treatment on maize (Zea mays) stands establishment and seed rot caused by Pythium spp. at early planting season. Ph.D. Thesis. Iowa State University. 1994.

4. Castañedaa, LMF, Genroa, C, Roggiaa, I, Bendera, SS., Benderb, RJ, Pereiraa, CN. Innovative rice seed coating (Oryza Sativa) with polymer nanofibres and microparticles using the electrospinning method. J. Res. Updates in Polymer Sci. 2014; 3(1),33-39.

5. Samac, DA, Schraber, S, Barclay, S. A mineral seed coating for control of seedling diseases of Alfalfa suitable for organic production systems. Plant Diseases. 2015; 99(5), 614-619.

6. Reus, HAM, Glas, J. Seed coating composition. Patent WO 2010107312 A1. 2010

7. Sharma, KK, Singh, US, Sharma, P, Kumar, A, Sharma, L. Seed treatments for sustainable agriculture – a review. J. Applied and Nat. Sci. 2015; 7(1), 521-539.

8. Epstein, E. Silicon. Annu. Rev. Plant Physiol. Plant Mol. Biol. 1999; 50, 641–664.

9. Biel, K, Matichenkov, V, Fomina, I. Role of silicon in plant defensive system. In: Keeping (Ed.). Silicon in agriculture conference, South Africa. 2008. p. 28.

10. Etesami, H, Jeong, BR. Silicon (Si): Review and future prospects on the action mechanisms in alleviating biotic and abiotic stresses in plants. Ecotoxicol. Environ. Saf. 2018; 147, 881–896.

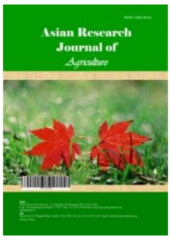
11. Priyono, J, Gilkes, RJ. 2008. Application of silicate rock fertilizers improves plant growth: a glasshouse assessment. Comm. Soil and Plant Anal. 2008; 39, 358–369.

12. Ali, A, Basra, SMA, Hussain, S, Iqbal, J, Bukhsa, MAAH, Saewar, M. Salt stress alleviation in field crops through nutritional supplementation of silicon. Pakistan J. Nutr. 2012; 11(8), 637-655.

13. Bennett WF. Plant nutrient utilization and diagnostic plant symptoms. In: Benett WF (Ed.). Nutrient deficiencies & toxicities in crop plants. APS Press, The American Phytopathological Society, St Paul Minnesota; 1993.

14. Gorim, L, Asch, F. Seed coating increases seed moisture uptake and restricts embryonic oxygen availability in germinating cereal seeds. Biology 2017; 6(31),1–14.

15. Priyono J, Sudharmawan AAK. Seed Coating with Organomineral Fertilizer, an Alternative Method to Improve the Efficiency of Farming. Asian R. J. Agr. 2020; 12(1),12-17.




*Asian Research Journal of Agriculture*

*X(X): XX-XX, 20YY; Article no.ARJA.92976*
*ISSN: 2456-561X*

# The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer

**Joko Priyono [a*] and Anak Agung Ketut Sudharmawan [b]**

*[a] Department of Soil Science, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia.*
*[b] Department of Agroecotechnology, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia.*

***Authors' contributions***

*This work was carried out in collaboration between both authors. Author JP designed the study, technical aspects of seed coating, constructs the outline and wrote the first draft of the manuscripts. Author AAKS performed the statistical analysis and managed the literature searches for seed treatments. Both authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/ARJA/2022/XXXXX

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:

***Original Research Article***

***Received ………….. 20YY***
***Accepted ………….. 20YY***
***Published ……….. 20YY***



## ABSTRACT

Seed coating with silicate rock-basis organomineral fertilizer (OMF) was proposed as an appropriate method to improve the productivity and profitability of rice farming. This research aimed to evaluate the growth and yield components of rice grown from coated seeds with N-enriched OMF. The coated seeds of two rice varieties, i.e., Trisakti (T) and Nutri Zinc (NZ) were tested in separate experimental sets. A randomized block design was applied for each experiment with the treatment consisting of non-coated seed (NCS), coated seeds containing 4.5 % N (CS-1), 7.8 % N (CS-2), and 9.0 % N (CS-3) in 3 blocks. The coating material of OMF was a mixture of 90 % basaltic rock and 10 % rock phosphate, enriched with N accordingly to the treatment; and the weight ratio of seed to OMF was about 1:16. The coated seeds were planted directly to the ground (without sowing and transplanting steps), and only NCS was fertilized with NPK (15:15:15) equivalent to 300 kg. $ha^{-1}$. Results reveal that there was no significant difference in growth components (number of tillers and the weight of top-biomass) and quality of rice grains (weight of 1,000 grains) for the plants of coated and non-coated seeds. Enriching OMF with N up to 9 % consistently improved the total yield of rice. Therefore, seed coating with OMF containing about 9 % N was an appropriate method to optimize rice yield.

**Corresponding author: E-mail: jokotanahunram@gmail.com;*

*Keywords: Organomineral fertilizer; coating materials; seed coating; silicate rock fertilizer.*

## 1. INTRODUCTION

Seed industries have applied seed coating technology for decades aimed mainly to improve the productivity and profitability of farming. Most of the seed coatings, however, were designed to protect the seeds from the attack of soil-borne pathogens [1]. Consequently, the used coating materials contained various pesticides including fungicides and rodenticides [2,3,4], with supplementary plant nutrients [5], or zeolite [6]. Because exposing toxic pesticides to farming land can develop pest resistance and create various negative-ecological effects, the use of synthetic pesticides as the seed coating material should be avoided [7]. This is a major challenge for seed industries to develop coated seeds with more environmentally friendly materials.

Referring to the above case, we developed the coated seed of rice with local abundance and environmentally friendly materials, which was silicate rock-based-organomineral fertilizer (OMF), by applying different approach. Improving the productivity and profitability of farming was not by protecting the seeds or plants from the attack of pests and pathogens, but by maximizing the healthiness and resistance of plants to biotic and abiotic stresses using OMF. Practically, the plants were supplied with proportional essential and functional (Si) nutrients in form of OMF.

The components of OMF were mainly the finely ground basaltic and some phosphatic rocks, enriched with nitrogen substances. The OMF was designed as the main source of all plant-essential nutrients to support the optimum plant growth and yield and supply a functional nutrient of silicate (Si) to maximize the resistance of plants to biotic and abiotic stresses [8,9,10] without additional fertilizer. In addition, the OMF may also act as a remediating agent for disordered plant-growing media such as acidic [11] or salt-affected [12] soils.

Rice is a non-legume plant requiring a large amount of nitrogen (N) for optimum growth [13]. On the other hand, enriching the coating material with a high concentration of N fertilizers (e.g., urea) may create a technical problem in the coating process. It was because covering the seeds with materials containing a high concentration of N may toxify and stop the coated seed germination. In addition, the thickness of coated material may limit oxygen availability for the seed-embryonic tissue [14] delaying the germination process. Thus, the appropriate concentration of N as well as the thickness and suitable procedure of coating process must be found.

Results of a greenhouse assessment for the performance of the coated seeds of rice with OMF [15] showed that adding N to the coating material up to 2.5 % was not sufficient to gain optimum growth and yield. Following up on that finding, this present research was intended to find out an appropriate method of adding enough N to the coating material (OMF), so that the plants from the coated seeds grow and yield optimally without additional N fertilizer.

The main objective of this research was to find out the most suitable amount of N added to the coating material (OMF), by evaluating the growth and yield components of the OMF-coated seeds compared to those of the non-coated seeds.

## 2. MATERIALS AND METHODS

### 2.1 Coating Materials and Process

The coating material of OMF and its chemical composition were like that used in the previous research [15]. The OMF consisted of basaltic rocks (90 %) and rock phosphate (10 %). Those rocks were mixed and finely ground with a horizontal-ball mill machine for 30 minutes producing very fine particles having a median diameter ($D_{50}$) of 22 µm. Three types of coated seeds were prepared with different concentrations of N in the coating material (see Table 1). The binding solution for the first layer was Tapioca starch solution (1 %), and for the second layer was urea + Orrin. Besides binding material, Orrin was functioned also as a supplementary nutrient source and a converting agent of urea ($(NH_2)_2CO$) to $NH_4^+$ limiting volatilization of N during the coating process. The rice seeds of Trisakti (T) and Nutri Zinc (ZN) varieties were used in this experiment.

**Table 1. The composition of seed coating material used in this experiment**

| Type of Coated Seed | Seeds (g) | OMF (g) | Binding solution | |
|---|---|---|---|---|
| | | | 1st layer | 2nd layer |
| CS-1 | 250 | 4,000 | Starch sol. (1 %) | 50 g urea + 150 mL Orrin*) |
| CS-2 | 250 | 4,000 | Starch sol. (1 %) | 75 g urea + 150 mL Orrin |
| CS-3 | 250 | 4,000 | Starch sol. (1 %) | 100 g urea + 150 mL Orrin |

**) The trademark of a liquid-silicate rock fertilizer with the matrix solution of citric acid, pH 3.5*

The process of seed coating used a 150-L stainless steel rotary drum that was horizontally rotated at the speed of 80 - 100 rpm. The seeds (250 g) were coated with OMF in two layering steps by using the binding solutions described in Table 1. For the first coating layer, the third part (about 1,500 g) of OMF was applied step-by-step in sequence with spraying the starch solution to cover the seeds. The remaining OMF was applied to the seeds in the same method but using the binder of urea + Orrin. The coated seeds were dried with a hand dryer (< 40$^o$ C) in the rotating drum for about 30 minutes, then were taken out from the drum, dried completely under sunray to reach constant moisture (< 10 %), and stored in a closed container. Before planting, the produced coated seeds were tested for their germination rate in a growth chamber. Results of the test confirmed that the coated seeds used in this research were very good – germinated > 95%.

## 2.2 Experimental Setting

The experiment was conducted on an irrigated paddy soil classified as Oxyaquic Hapluderts in Keruak Village - Central Lombok Regency, Indonesia. The soil was clay textured (46 % clay), having a low content of total C-organic (1.2 %) and total N (0.02 %); the Olsen-extractable $P_2O_5$ was 16 mg. kg$^{-1}$, the acidity was about neutral (pH 7.2); the cation exchange capacity of the soil was 36.2 cmol. kg$^{-1}$, and the exchangeable K, Ca, Mg, and Na respectively were 0.14, 32.4, 4.4, and 0.1 cmol. kg$^{-1}$.

The agronomic performances of the coated seeds of each variety were tested in separate experimental sets. A randomized block design was laid out for each experimental set with the treatment consisting of non-coated seed (NCS), CS-1, CS-2, and CS-3 in 3 blocks. The size of an experimental unit (plot) was 5 m x 5 m, and between plots were separated by a 50-cm borderline. The soil was mechanically cultivated by plugging, mudding, smoothing, and allowed to equilibrate for two days in a saturated condition. The seeds were planted directly onto the saturated ground without germination or transplanting steps. Five seeds were planted per planting point with a spacing of 25 cm x 25 cm. The water level in each plot was maintained at 1 – 5 cm over the soil surface accordingly to the growing stage of the plants. Only the non-NCS plants were fertilized with NPK (15:15:15) at the rate equivalent to 300 kg. ha$^{-1}$. Harvesting was done 110 days after planting.

## 2.3 Data and Statistical Analyses

The main collected data (parameters) were the number of productive tillers, the weight of top-dry biomass, and whole and 1,000 grains. The analysis of variance (ANOVA) was carried out for each set of data, and the parameters significantly affected by the treatment were further evaluated with the least significant difference (LSD) method at $\alpha = 0.05$.

# 3. RESULTS AND DISCUSSION

## 3.1 The Growth Components

The number of productive tillers per hill and the weight of top-dry biomass were presented in Table 2. In addition, it was observed that the coated seeds germinated 3 – 5 days later than the non-coated ones; and there was no indication of N-deficient symptoms of plant leaf (data are not shown in this paper).

Statistically, there were no significant differences in growth performance (number of productive tillers and weight of dry-top biomass) between rice plants from the non-coated and coated seeds, either for the Trisakti or Nutri Zinc varieties. As shown in Table 2, the number of productive tellers per plot was about 35, and the weight of dry-top biomass per plot was about 17.5 kg. Based on the plant growth data, it may be interpreted that the effect of seed coating with OMF on the growth components of rice was similar to that for the application of synthetic fertilizer (NPK 300 kg. ha$^{-1}$).

**Table 2. The number (mean ± Sdev) of tillers and weight of top-dry biomass for Trisakti and Nutri Zinc Varieties**

| Type of Seeds | Number of Productive Tillers per Hill*) | | Top-Dry Biomass (kg.plot$^{-1}$) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (34.3 ± 1.2) | (34.3 ± 1.0) | (17.7 ± 0.5) | (17.8 ± 1.5) |
| CS-1 | (36.1 ± 0.5) | (34.6 ± 1.0) | (18.0 ± 0.4) | (18.2 ± 0.4) |
| CS-2 | (35.1 ± 1.0) | (34.7 ± 0.7) | (18.6 ± 0.7) | (18.8 ± 0.4) |
| CS-3 | (37.6 ± 1.1) | (34.9 ± 0.7) | (18.7 ± 0.4) | (19.4 ± 0.3) |

*) *Average values from 20-randomly sub-sampled plant hills*

**Table 3. The weights (mean ± Sdev) of whole and 1,000 grains for Trisakti and Nutri Zinc Varieties**

| Type of Seeds | Weight of Whole Grains (kg. plot$^{-1}$)*) | | Weight of 1,000 Grains (g) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (14.42 ± 1.56) a | (14.22 ± 1.28) a | (28.59 ± 0.71) | (26.83 ± 0.62) |
| CS-1 | (13.72 ± 0.70) a | (14.17 ± 0.76) a | (28.17 ± 0.85) | (26.91 ± 1.01) |
| CS-2 | (15.74 ± 0.37) b | (15.38 ± 0.33) ab | (26.03 ± 1.34) | (27.09 ± 0.67) |
| CS-3 | (16.52 ± 0.48) c | (16.73 ± 0.64) b | (28.52 ± 0.96) | (26.52 ± 0.96) |
| $LSD_{\alpha=0.05}$ | 0.77 | 1.28 | - | - |

*) *The values followed by the same letters are not significantly different based on the analysis of* $LSD_{\alpha=0.05}$

## 3.2 Yield Components

The yield components, i.e., the weights of whole grains per plot of 25 m$^2$ and 1,000 grains, were presented in Table 3. Results of analysis of variance showed that the quantity of rice yield for non-coated seeds was significantly different from that for the coated seeds, but there was no significant effect of the different types of seeds on the quality of rice grain (weight of 1,000 grains).

As shown in that Table 3, the rice yields were consistently improved by the increases of N concentration in the coating material OMF; and the highest yields were gained by the plants of CS-3, which were about 16.6 kg. plot$^{-1}$ (equivalent to 6,640 kg. ha$^{-1}$). Based on the results, coating the rice seeds with OMF containing about 9 % N was a suitable method to optimize production.

## 4. CONCLUSION

The growth components (number of tillers and weight of biomass) and grain quality (weight of 1,000 grains) of the rice plants grown from the non-coated seeds were similar to those for the coated seeds with the N-enriched OMF. On the other hand, adding N up to 9 % to the coating material (OMF) improved the grain yield of rice plants from the coated seeds, and the seed coating method was a suitable method to optimize production. By planting the OMF-coated seeds, farmers may gain optimum yield without applying additional fertilizers.

## ACKNOWLEDGEMENTS

The authors thank The Directorate of Higher Education, The Ministry of Research, Technology and Higher Education, The Republic of Indonesia for its financial support for the research.

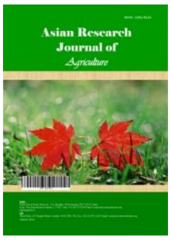
## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Hill HJ. Recent development of seed technology. J. New Seeds. 1999;1(1):105-112.
2. Hazra DK, Patanjali PK. Seed coating formulation technologies: an environmental biology friendly approaches for sustainable agriculture. Bioscience Methods. 2016; 7(5):1-10.
3. Arias-Rivas, B. Evaluation of seed coating treatment on maize (*Zea mays*) stands establishment and seed rot caused by

*Pythium* spp. at early planting season. Ph.D. Thesis. Iowa State University; 1994.
4. Castañedaa LMF, Genroa C, Roggiaa I, Bendera SS, Benderb RJ, Pereiraa CN. Innovative rice seed coating (*Oryza sativa*) with polymer nanofibres and microparticles using the electrospinning method. J. Res. Updates in Polymer Sci. 2014;3(1):33-39.
5. Samac DA, Schraber S, Barclay S. A mineral seed coating for control of seedling diseases of Alfalfa suitable for organic production systems. Plant Diseases. 2015; 99(5):614-619.
6. Reus HAM, Glas J. Seed coating composition. Patent WO 2010107312 A1; 2010
7. Sharma KK, Singh US, Sharma P, Kumar A, Sharma L. Seed treatments for sustainable agriculture – a review. J. Applied and Nat. Sci. 2015;7(1):521-539.
8. Epstein E. Silicon. Annu. Rev. Plant Physiol. Plant Mol. Biol. 1999;50:641–664.
9. Biel K, Matichenkov V, Fomina I. Role of silicon in plant defensive system. In: Keeping (Ed.). Silicon in agriculture conference, South Africa. 2008;28.
10. Etesami H, Jeong BR. Silicon (Si): Review and future prospects on the action mechanisms in alleviating biotic and abiotic stresses in plants. Ecotoxicol. Environ. Saf. 2018;147:881–896.
11. Priyono J, Gilkes RJ. Application of silicate rock fertilizers improves plant growth: A glasshouse assessment. Comm. Soil and Plant Anal. 2008;39:358–369.
12. Ali A, Basra SMA, Hussain S, Iqbal J, Bukhsa MAAH, Saewar M. Salt stress alleviation in field crops through nutritional supplementation of silicon. Pakistan J. Nutr. 2012;11(8):637-655.
13. Bennett WF. Plant nutrient utilization and diagnostic plant symptoms. In: Benett WF (Ed.). Nutrient deficiencies & toxicities in crop plants. APS Press, the American Phytopathological Society, St Paul Minnesota; 1993.
14. Gorim L, Asch F. Seed coating increases seed moisture uptake and restricts embryonic oxygen availability in germinating cereal seeds. Biology. 2017; 6(31):1–14.
15. Priyono J, Sudharmawan AAK. Seed coating with organomineral fertilizer, an alternative method to improve the efficiency of farming. Asian R. J. Agr. 2020;12(1):12-17.



*Asian Research Journal of Agriculture*

***X(X): XX-XX, 20YY; Article no.ARJA.92976***
***ISSN: 2456-561X***

# The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer

**Joko Priyono [a*] and Anak Agung Ketut Sudharmawan [b]**

*[a] Department of Soil Science, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia.*
*[b] Department of Agroecotechnology, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia.*

***Authors' contributions***

*This work was carried out in collaboration between both authors. Author JP designed the study, technical aspects of seed coating, constructs the outline and wrote the first draft of the manuscripts. Author AAKS performed the statistical analysis and managed the literature searches for seed treatments. Both authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/ARJA/2022/XXXXX

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:

***Original Research Article***

***Received ………….. 20YY***
***Accepted ………….. 20YY***
***Published ……….. 20YY***



## ABSTRACT

Seed coating with silicate rock-basis organomineral fertilizer (OMF) was proposed as an appropriate method to improve the productivity and profitability of rice farming. This research aimed to evaluate the growth and yield components of rice grown from coated seeds with N-enriched OMF. The coated seeds of two rice varieties, i.e., Trisakti (T) and Nutri Zinc (NZ) were tested in separate experimental sets. A randomized block design was applied for each experiment with the treatment consisting of non-coated seed (NCS), coated seeds containing 4.5 % N (CS-1), 7.8 % N (CS-2), and 9.0 % N (CS-3) in 3 blocks. The coating material of OMF was a mixture of 90 % basaltic rock and 10 % rock phosphate, enriched with N accordingly to the treatment; and the weight ratio of seed to OMF was about 1:16. The coated seeds were planted directly to the ground (without sowing and transplanting steps), and only NCS was fertilized with NPK (15:15:15) equivalent to 300 kg. $ha^{-1}$. Results reveal that there was no significant difference in growth components (number of tillers and the weight of top-biomass) and quality of rice grains (weight of 1,000 grains) for the plants of coated and non-coated seeds. Enriching OMF with N up to 9 % consistently improved the total yield of rice. Therefore, seed coating with OMF containing about 9 % N was an appropriate method to optimize rice yield.

**Corresponding author: E-mail: jokotanahunram@gmail.com;*

*Keywords: Organomineral fertilizer; coating materials; seed coating; silicate rock fertilizer.*

## 1. INTRODUCTION

Seed industries have applied seed coating technology for decades aimed mainly to improve the productivity and profitability of farming. Most of the seed coatings, however, were designed to protect the seeds from the attack of soil-borne pathogens [1]. Consequently, the used coating materials contained various pesticides including fungicides and rodenticides [2,3,4], with supplementary plant nutrients [5], or zeolite [6]. Because exposing toxic pesticides to farming land can develop pest resistance and create various negative-ecological effects, the use of synthetic pesticides as the seed coating material should be avoided [7]. This is a major challenge for seed industries to develop coated seeds with more environmentally friendly materials.

Referring to the above case, we developed the coated seed of rice with local abundance and environmentally friendly materials, which was silicate rock-based-organomineral fertilizer (OMF), by applying different approach. Improving the productivity and profitability of farming was not by protecting the seeds or plants from the attack of pests and pathogens, but by maximizing the healthiness and resistance of plants to biotic and abiotic stresses using OMF. Practically, the plants were supplied with proportional essential and functional (Si) nutrients in form of OMF.

The components of OMF were mainly the finely ground basaltic and some phosphatic rocks, enriched with nitrogen substances. The OMF was designed as the main source of all plant-essential nutrients to support the optimum plant growth and yield and supply a functional nutrient of silicate (Si) to maximize the resistance of plants to biotic and abiotic stresses [8,9] without additional fertilizer [10]. In addition, the OMF may also act as a remediating agent for disordered plant-growing media such as acidic [11] or salt-affected [12] soils.

Please check the highlighted reference no.

Rice is a non-legume plant requiring a large amount of nitrogen (N) for optimum growth [13]. On the other hand, enriching the coating material with a high concentration of N fertilizers (e.g., urea) may create a technical problem in the coating process. It was because covering the seeds with materials containing a high concentration of N may toxify and stop the coated seed germination. In addition, the thickness of coated material may limit oxygen availability for the seed-embryonic tissue [14] delaying the germination process. Thus, the appropriate concentration of N as well as the thickness and suitable procedure of coating process must be found.

Results of a greenhouse assessment for the performance of the coated seeds of rice with OMF [15] showed that adding N to the coating material up to 2.5 % was not sufficient to gain optimum growth and yield. Following up on that finding, this present research was intended to find out an appropriate method of adding enough N to the coating material (OMF), so that the plants from the coated seeds grow and yield optimally without additional N fertilizer.

The main objective of this research was to find out the most suitable amount of N added to the coating material (OMF), by evaluating the growth and yield components of the OMF-coated seeds compared to those of the non-coated seeds.

## 2. MATERIALS AND METHODS

### 2.1 Coating Materials and Process

The coating material of OMF and its chemical composition were like that used in the previous research [15]. The OMF consisted of basaltic rocks (90 %) and rock phosphate (10 %). Those rocks were mixed and finely ground with a horizontal-ball mill machine for 30 minutes producing very fine particles having a median diameter ($D_{50}$) of 22 µm. Three types of coated seeds were prepared with different concentrations of N in the coating material (see Table 1). The binding solution for the first layer was Tapioca starch solution (1 %), and for the second layer was urea + Orrin. Besides binding material, Orrin was functioned also as a supplementary nutrient source and a converting agent of urea ($(NH_2)_2CO$) to $NH_4^+$ limiting volatilization of N during the coating process. The rice seeds of Trisakti (T) and Nutri Zinc (ZN) varieties were used in this experiment.

**Table 1. The composition of seed coating material used in this experiment**

| Type of Coated Seed | Seeds (g) | OMF (g) | Binding solution | |
|---|---|---|---|---|
| | | | 1st layer | 2nd layer |
| CS-1 | 250 | 4,000 | Starch sol. (1 %) | 50 g urea + 150 mL Orrin*) |
| CS-2 | 250 | 4,000 | Starch sol. (1 %) | 75 g urea + 150 mL Orrin |
| CS-3 | 250 | 4,000 | Starch sol. (1 %) | 100 g urea + 150 mL Orrin |

*) *The trademark of a liquid-silicate rock fertilizer with the matrix solution of citric acid, pH 3.5*

The process of seed coating used a 150-L stainless steel rotary drum that was horizontally rotated at the speed of 80 - 100 rpm. The seeds (250 g) were coated with OMF in two layering steps by using the binding solutions described in Table 1. For the first coating layer, the third part (about 1,500 g) of OMF was applied step-by-step in sequence with spraying the starch solution to cover the seeds. The remaining OMF was applied to the seeds in the same method but using the binder of urea + Orrin. The coated seeds were dried with a hand dryer (< $40^o$ C) in the rotating drum for about 30 minutes, then were taken out from the drum, dried completely under sunray to reach constant moisture (< 10 %), and stored in a closed container. Before planting, the produced coated seeds were tested for their germination rate in a growth chamber. Results of the test confirmed that the coated seeds used in this research were very good – germinated > 95%.

### 2.2 Experimental Setting

The experiment was conducted on an irrigated paddy soil classified as Oxyaquic Hapluderts in Keruak Village - Central Lombok Regency, Indonesia. The soil was clay textured (46 % clay), having a low content of total C-organic (1.2 %) and total N (0.02 %); the Olsen-extractable $P_2O_5$ was 16 mg. $kg^{-1}$, the acidity was about neutral (pH 7.2); the cation exchange capacity of the soil was 36.2 cmol. $kg^{-1}$, and the exchangeable K, Ca, Mg, and Na respectively were 0.14, 32.4, 4.4, and 0.1 cmol. $kg^{-1}$.

The agronomic performances of the coated seeds of each variety were tested in separate experimental sets. A randomized block design was laid out for each experimental set with the treatment consisting of non-coated seed (NCS), CS-1, CS-2, and CS-3 in 3 blocks. The size of an experimental unit (plot) was 5 m x 5 m, and between plots were separated by a 50-cm borderline. The soil was mechanically cultivated by plugging, mudding, smoothing, and allowed to equilibrate for two days in a saturated condition. The seeds were planted directly onto the saturated ground without germination or transplanting steps. Five seeds were planted per planting point with a spacing of 25 cm x 25 cm. The water level in each plot was maintained at 1 – 5 cm over the soil surface accordingly to the growing stage of the plants. Only the non-NCS plants were fertilized with NPK (15:15:15) at the rate equivalent to 300 kg. $ha^{-1}$. Harvesting was done 110 days after planting.

### 2.3 Data and Statistical Analyses

The main collected data (parameters) were the number of productive tillers, the weight of top-dry biomass, and whole and 1,000 grains. The analysis of variance (ANOVA) was carried out for each set of data, and the parameters significantly affected by the treatment were further evaluated with the least significant difference (LSD) method at $\alpha = 0.05$.

## 3. RESULTS AND DISCUSSION

### 3.1 The Growth Components

The number of productive tillers per hill and the weight of top-dry biomass were presented in Table 2. In addition, it was observed that the coated seeds germinated 3 – 5 days later than the non-coated ones; and there was no indication of N-deficient symptoms of plant leaf (data are not shown in this paper).

Statistically, there were no significant differences in growth performance (number of productive tillers and weight of dry-top biomass) between rice plants from the non-coated and coated seeds, either for the Trisakti or Nutri Zinc varieties. As shown in Table 2, the number of productive tellers per plot was about 35, and the weight of dry-top biomass per plot was about 17.5 kg. Based on the plant growth data, it may be interpreted that the effect of seed coating with OMF on the growth components of rice was similar to that for the application of synthetic fertilizer (NPK 300 kg. $ha^{-1}$).

**Table 2. The number (mean ± Sdev) of tillers and weight of top-dry biomass for Trisakti and Nutri Zinc Varieties**

| Type of Seeds | Number of Productive Tillers per Hill*) | | Top-Dry Biomass (kg.plot$^{-1}$) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (34.3 ± 1.2) | (34.3 ± 1.0) | (17.7 ± 0.5) | (17.8 ± 1.5) |
| CS-1 | (36.1 ± 0.5) | (34.6 ± 1.0) | (18.0 ± 0.4) | (18.2 ± 0.4) |
| CS-2 | (35.1 ± 1.0) | (34.7 ± 0.7) | (18.6 ± 0.7) | (18.8 ± 0.4) |
| CS-3 | (37.6 ± 1.1) | (34.9 ± 0.7) | (18.7 ± 0.4) | (19.4 ± 0.3) |

*) *Average values from 20-randomly sub-sampled plant hills*

**Table 3. The weights (mean ± Sdev) of whole and 1,000 grains for Trisakti and Nutri Zinc Varieties**

| Type of Seeds | Weight of Whole Grains (kg. plot$^{-1}$)*) | | Weight of 1,000 Grains (g) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (14.42 ± 1.56) a | (14.22 ± 1.28) a | (28.59 ± 0.71) | (26.83 ± 0.62) |
| CS-1 | (13.72 ± 0.70) a | (14.17 ± 0.76) a | (28.17 ± 0.85) | (26.91 ± 1.01) |
| CS-2 | (15.74 ± 0.37) b | (15.38 ± 0.33) ab | (26.03 ± 1.34) | (27.09 ± 0.67) |
| CS-3 | (16.52 ± 0.48) c | (16.73 ± 0.64) b | (28.52 ± 0.96) | (26.52 ± 0.96) |
| $LSD_{\alpha=0.05}$ | 0.77 | 1.28 | - | - |

*) *The values followed by the same letters are not significantly different based on the analysis of* $LSD_{\alpha=0.05}$

### 3.2 Yield Components

The yield components, i.e., the weights of whole grains per plot of 25 $m^2$ and 1,000 grains, were presented in Table 3. Results of analysis of variance showed that the quantity of rice yield for non-coated seeds was significantly different from that for the coated seeds, but there was no significant effect of the different types of seeds on the quality of rice grain (weight of 1,000 grains).

As shown in that Table 3, the rice yields were consistently improved by the increases of N concentration in the coating material OMF; and the highest yields were gained by the plants of CS-3, which were about 16.6 kg. plot$^{-1}$ (equivalent to 6,640 kg. ha$^{-1}$). Based on the results, coating the rice seeds with OMF containing about 9 % N was a suitable method to optimize production.

## 4. CONCLUSION

The growth components (number of tillers and weight of biomass) and grain quality (weight of 1,000 grains) of the rice plants grown from the non-coated seeds were similar to those for the coated seeds with the N-enriched OMF. On the other hand, adding N up to 9 % to the coating material (OMF) improved the grain yield of rice plants from the coated seeds, and the seed coating method was a suitable method to optimize production. By planting the OMF-coated seeds, farmers may gain optimum yield without applying additional fertilizers.

## ACKNOWLEDGEMENTS

The authors thank The Directorate of Higher Education, The Ministry of Research, Technology and Higher Education, The Republic of Indonesia for its financial support for the research.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Hill HJ. Recent development of seed technology. J. New Seeds. 1999;1(1):105-112.
2. Hazra DK, Patanjali PK. Seed coating formulation technologies: an environmental biology friendly approaches for sustainable agriculture. Bioscience Methods. 2016; 7(5):1-10.
3. Arias-Rivas, B. Evaluation of seed coating treatment on maize (*Zea mays*) stands establishment and seed rot caused by

*Pythium* spp. at early planting season. Ph.D. Thesis. Iowa State University; 1994.
4. Castañedaa LMF, Genroa C, Roggiaa I, Bendera SS, Benderb RJ, Pereiraa CN. Innovative rice seed coating (*Oryza sativa*) with polymer nanofibres and microparticles using the electrospinning method. J. Res. Updates in Polymer Sci. 2014;3(1):33-39.
5. Samac DA, Schraber S, Barclay S. A mineral seed coating for control of seedling diseases of Alfalfa suitable for organic production systems. Plant Diseases. 2015; 99(5):614-619.
6. Reus HAM, Glas J. Seed coating composition. Patent WO 2010107312 A1; 2010
7. Sharma KK, Singh US, Sharma P, Kumar A, Sharma L. Seed treatments for sustainable agriculture – a review. J. Applied and Nat. Sci. 2015;7(1):521-539.
8. Epstein E. Silicon. Annu. Rev. Plant Physiol. Plant Mol. Biol. 1999;50:641–664.
9. Biel K, Matichenkov V, Fomina I. Role of silicon in plant defensive system. In: Keeping (Ed.). Silicon in agriculture conference, South Africa. 2008;28.
10. Etesami H, Jeong BR. Silicon (Si): Review and future prospects on the action mechanisms in alleviating biotic and abiotic stresses in plants. Ecotoxicol. Environ. Saf. 2018;147:881–896.
11. Priyono J, Gilkes RJ. Application of silicate rock fertilizers improves plant growth: A glasshouse assessment. Comm. Soil and Plant Anal. 2008;39:358–369.
12. Ali A, Basra SMA, Hussain S, Iqbal J, Bukhsa MAAH, Saewar M. Salt stress alleviation in field crops through nutritional supplementation of silicon. Pakistan J. Nutr. 2012;11(8):637-655.
13. Bennett WF. Plant nutrient utilization and diagnostic plant symptoms. In: Benett WF (Ed.). Nutrient deficiencies & toxicities in crop plants. APS Press, the American Phytopathological Society, St Paul Minnesota; 1993.
14. Gorim L, Asch F. Seed coating increases seed moisture uptake and restricts embryonic oxygen availability in germinating cereal seeds. Biology. 2017; 6(31):1–14.
15. Priyono J, Sudharmawan AAK. Seed coating with organomineral fertilizer, an alternative method to improve the efficiency of farming. Asian R. J. Agr. 2020;12(1):12-17.

Gmail

Search in mail

3 of 3,802

Compose

Inbox 1,315

Starred

Snoozed

Important

Sent

Drafts

Categories

Social 6

Updates 102

Forums

Promotions 10

More

Labels

Junk E-mail

Personal

More

# Minor review comments for manuscript number: 2022/ARJA /92976

Inbox ×

Editor PRM 3 <sdi.3@sciencedomain.org> Oct 14, 2022, 6:19 PM (6 hours ago)

to me

Dear Dr. Joko Priyono,

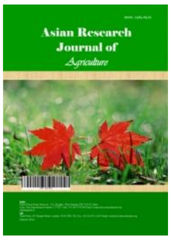
We are contacting from **Asian Research Journal of Agriculture** regarding Manuscript Number. 2022/ARJA /92976

Title of the Manuscript: The Agronomic Performance of Rice Seeds Coated with N-Enriched Organominer Fertilizer

All review comments ( 02 nos.) are attached with this email.
Please do the correction as per the review comments in the following file
File name: Ms_ARJA_92976

Deadline:
Authors are requested to send revised paper as soon as possible (within 2-3 days) to accelerate the pre-publication formalities. If we receive the revised version within this deadline, the paper can be published in t current issue of the journal within 7 days. If extra time is required, kindly inform us.

Revised paper:
1. Comments of all the reviewers should be addressed during revision. Authors are requested to submit the revised paper with all the corrections highlighted in yellow color (for example. abc……………efg).




*Asian Research Journal of Agriculture*

***X(X): XX-XX, 20YY; Article no.ARJA.92976***
***ISSN: 2456-561X***

# The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer

**Joko Priyono [a*] and Anak Agung Ketut Sudharmawan [b]**

*[a] Department of Soil Science, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia.*
*[b] Department of Agroecotechnology, University of Mataram, Jalan Pendidikan 37 Mataram, Lombok Island, Indonesia.*

***Authors' contributions***

*This work was carried out in collaboration between both authors. Author JP designed the study, technical aspects of seed coating, constructs the outline and wrote the first draft of the manuscripts. Author AAKS performed the statistical analysis and managed the literature searches for seed treatments. Both authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/ARJA/2022/XXXXX

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:

***Original Research Article***

***Received ………….. 20YY***
***Accepted ………….. 20YY***
***Published ……….. 20YY***

## ABSTRACT

Seed coating with silicate rock-basis organomineral fertilizer (OMF) was proposed as an appropriate method to improve the productivity and profitability of rice farming. This research aimed to evaluate the growth and yield components of rice grown from coated seeds with N-enriched OMF. The coated seeds of two rice varieties, i.e., Trisakti (T) and Nutri Zinc (NZ) were tested in separate experimental sets. A randomized block design was applied for each experiment with the treatment consisting of non-coated seed (NCS), coated seeds containing 4.5% N (CS-1), 7.8% N (CS-2), and 9.0% N (CS-3) in 3 blocks. The coating material of OMF was a mixture of 90% basaltic rock and 10% rock phosphate, enriched with N accordingly to the treatment; and the weight ratio of seed to OMF was about 1:16. The coated seeds were planted directly to the ground (without sowing and transplanting steps), and only NCS was fertilized with NPK (15:15:15) equivalent to 300 kg. $ha^{-1}$. Results reveal that there was no significant difference in growth components (number of tillers and the weight of top-biomass) and quality of rice grains (weight of 1,000 grains) for the plants of coated and non-coated seeds. Enriching OMF with N up to 9% consistently improved the total yield of rice. Therefore, seed coating with OMF containing about 9% N was an appropriate method to optimize rice yield.

**Corresponding author: E-mail: jokotanahunram@gmail.com;*

*Keywords: Organomineral fertilizer; coating materials; seed coating; silicate rock fertilizer.*

## 1. INTRODUCTION

Seed industries have applied seed coating technology for decades aimed mainly to improve the productivity and profitability of farming. Most of the seed coatings, however, were designed to protect the seeds from the attack of soil-borne pathogens [1]. Consequently, the used coating materials contained various pesticides including fungicides and rodenticides [2,3,4], with supplementary plant nutrients [5], or zeolite [6]. Because exposing toxic pesticides to farming land can develop pest resistance and create various negative-ecological effects, the use of synthetic pesticides as the seed coating material should be avoided [7]. This is a major challenge for seed industries to develop coated seeds with more environmentally friendly materials.

Referring to the above case, we developed the coated seed of rice with local abundance and environmentally friendly materials, which was silicate rock-based-organomineral fertilizer (OMF), by applying different approach. Improving the productivity and profitability of farming was not by protecting the seeds or plants from the attack of pests and pathogens, but by maximizing the healthiness and resistance of plants to biotic and abiotic stresses using OMF. Practically, the plants were supplied with proportional essential and functional (Si) nutrients in form of OMF.

The components of OMF were mainly the finely ground basaltic and some phosphatic rocks, enriched with nitrogen substances. The OMF was designed as the main source of all plant-essential nutrients to support the optimum plant growth and yield and supply a functional nutrient of silicate (Si) to maximize the resistance of plants to biotic and abiotic stresses [8,9,10] without additional fertilizer. In addition, the OMF may also act as a remediating agent for disordered plant-growing media such as acidic [11] or salt-affected [12] soils.

Rice is a non-legume plant requiring a large amount of nitrogen (N) for optimum growth [13]. On the other hand, enriching the coating material with a high concentration of N fertilizers (e.g., urea) may create a technical problem in the coating process. It was because covering the seeds with materials containing a high concentration of N may toxify and stop the coated seed germination. In addition, the thickness of coated material may limit oxygen availability for the seed-embryonic tissue [14] delaying the germination process. Thus, the appropriate concentration of N as well as the thickness and suitable procedure of coating process must be found.

Results of a greenhouse assessment for the performance of the coated seeds of rice with OMF [15] showed that adding N to the coating material up to 2.5% was not sufficient to gain optimum growth and yield. Following up on that finding, this present research was intended to find out an appropriate method of adding enough N to the coating material (OMF), so that the plants from the coated seeds grow and yield optimally without additional N fertilizer.

The main objective of this research was to find out the most suitable amount of N added to the coating material (OMF), by evaluating the growth and yield components of the OMF-coated seeds compared to those of the non-coated seeds.

## 2. MATERIALS AND METHODS

### 2.1 Coating Materials and Process

The coating material of OMF and its chemical composition were like that used in the previous research [15]. The OMF consisted of basaltic rocks (90%) and rock phosphate (10%). Those rocks were mixed and finely ground with a horizontal-ball mill machine for 30 minutes producing very fine particles having a median diameter ($D_{50}$) of 22 µm. Three types of coated seeds were prepared with different concentrations of N in the coating material (see Table 1). The binding solution for the first layer was Tapioca starch solution (1%), and for the second layer was urea + Orrin. Besides binding material, Orrin was functioned also as a supplementary nutrient source and a converting agent of urea ($(NH_2)_2CO$) to $NH_4^+$ limiting volatilization of N during the coating process. The rice seeds of Trisakti (T) and Nutri Zinc (ZN) varieties were used in this experiment.

**Table 1. The composition of seed coating material used in this experiment**

| Type of Coated Seed | Seeds (g) | OMF (g) | Binding solution | |
|---|---|---|---|---|
| | | | 1st layer | 2nd layer |
| CS-1 | 250 | 4,000 | Starch sol. (1%) | 50 g urea + 150 mL Orrin*) |
| CS-2 | 250 | 4,000 | Starch sol. (1%) | 75 g urea + 150 mL Orrin |
| CS-3 | 250 | 4,000 | Starch sol. (1%) | 100 g urea + 150 mL Orrin |

**) The trademark of a liquid-silicate rock fertilizer with the matrix solution of citric acid, pH 3.5*

The process of seed coating used a 150-L stainless steel rotary drum that was horizontally rotated at the speed of 80 - 100 rpm. The seeds (250 g) were coated with OMF in two layering steps by using the binding solutions described in Table 1. For the first coating layer, the third part (about 1,500 g) of OMF was applied step-by-step in sequence with spraying the starch solution to cover the seeds. The remaining OMF was applied to the seeds in the same method but using the binder of urea + Orrin. The coated seeds were dried with a hand dryer (< $40^o$ C) in the rotating drum for about 30 minutes, then were taken out from the drum, dried completely under sunray to reach constant moisture (< 10%), and stored in a closed container. Before planting, the produced coated seeds were tested for their germination rate in a growth chamber. Results of the test confirmed that the coated seeds used in this research were very good – germinated > 95%.

## 2.2 Experimental Setting

The experiment was conducted on an irrigated paddy soil classified as Oxyaquic Hapluderts in Keruak Village - Central Lombok Regency, Indonesia. The soil was clay textured (46% clay), having a low content of total C-organic (1.2%) and total N (0.02%); the Olsen-extractable $P_2O_5$ was 16 mg. $kg^{-1}$, the acidity was about neutral (pH 7.2); the cation exchange capacity of the soil was 36.2 cmol. $kg^{-1}$, and the exchangeable K, Ca, Mg, and Na respectively were 0.14, 32.4, 4.4, and 0.1 cmol. $kg^{-1}$.

The agronomic performances of the coated seeds of each variety were tested in separate experimental sets. A randomized block design was laid out for each experimental set with the treatment consisting of non-coated seed (NCS), CS-1, CS-2, and CS-3 in 3 blocks. The size of an experimental unit (plot) was 5 m x 5 m, and between plots were separated by a 50-cm borderline. The soil was mechanically cultivated by plugging, mudding, smoothing, and allowed to equilibrate for two days in a saturated condition. The seeds were planted directly onto the saturated ground without germination or transplanting steps. Five seeds were planted per planting point with a spacing of 25 cm x 25 cm. The water level in each plot was maintained at 1 – 5 cm over the soil surface accordingly to the growing stage of the plants. Only the non-NCS plants were fertilized with NPK (15:15:15) at the rate equivalent to 300 kg. $ha^{-1}$. Harvesting was done 110 days after planting.

## 2.3 Data and Statistical Analyses

The main collected data (parameters) were the number of productive tillers, the weight of top-dry biomass, and whole and 1,000 grains. The analysis of variance (ANOVA) was carried out for each set of data, and the parameters significantly affected by the treatment were further evaluated with the least significant difference (LSD) method at $\alpha = 0.05$.

# 3. RESULTS AND DISCUSSION

## 3.1 The Growth Components

The number of productive tillers per hill and the weight of top-dry biomass were presented in Table 2. In addition, it was observed that the coated seeds germinated 3 – 5 days later than the non-coated ones; and there was no indication of N-deficient symptoms of plant leaf (data are not shown in this paper).

Statistically, there were no significant differences in growth performance (number of productive tillers and weight of dry-top biomass) between rice plants from the non-coated and coated seeds, either for the Trisakti or Nutri Zinc varieties. As shown in Table 2, the number of productive tellers per plot was about 35, and the weight of dry-top biomass per plot was about 17.5 kg. Based on the plant growth data, it may be interpreted that the effect of seed coating with OMF on the growth components of rice was similar to that for the application of synthetic fertilizer (NPK 300 kg. $ha^{-1}$).

**Table 2. The number (mean ± Sdev) of tillers and weight of top-dry biomass for Trisakti and Nutri Zinc Varieties**

| Type of Seeds | Number of Productive Tillers per Hill*) | | Top-Dry Biomass ($kg.plot^{-1}$) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (34.3 ± 1.2) | (34.3 ± 1.0) | (17.7 ± 0.5) | (17.8 ± 1.5) |
| CS-1 | (36.1 ± 0.5) | (34.6 ± 1.0) | (18.0 ± 0.4) | (18.2 ± 0.4) |
| CS-2 | (35.1 ± 1.0) | (34.7 ± 0.7) | (18.6 ± 0.7) | (18.8 ± 0.4) |
| CS-3 | (37.6 ± 1.1) | (34.9 ± 0.7) | (18.7 ± 0.4) | (19.4 ± 0.3) |

*) *Average values from 20-randomly sub-sampled plant hills*

**Table 3. The weights (mean ± Sdev) of whole and 1,000 grains for Trisakti and Nutri Zinc Varieties**

| Type of Seeds | Weight of Whole Grains ($kg. plot^{-1}$)*) | | Weight of 1,000 Grains (g) | |
|---|---|---|---|---|
| | Trisakti | Nutri Zinc | Trisakti | Nutri Zinc |
| NCS | (14.42 ± 1.56) a | (14.22 ± 1.28) a | (28.59 ± 0.71) | (26.83 ± 0.62) |
| CS-1 | (13.72 ± 0.70) a | (14.17 ± 0.76) a | (28.17 ± 0.85) | (26.91 ± 1.01) |
| CS-2 | (15.74 ± 0.37) b | (15.38 ± 0.33) ab | (26.03 ± 1.34) | (27.09 ± 0.67) |
| CS-3 | (16.52 ± 0.48) c | (16.73 ± 0.64) b | (28.52 ± 0.96) | (26.52 ± 0.96) |
| $LSD_{\alpha=0.05}$ | 0.77 | 1.28 | - | - |

*) *The values followed by the same letters are not significantly different based on the analysis of* $LSD_{\alpha=0.05}$

## 3.2 Yield Components

The yield components, i.e., the weights of whole grains per plot of 25 $m^2$ and 1,000 grains, were presented in Table 3. Results of analysis of variance showed that the quantity of rice yield for non-coated seeds was significantly different from that for the coated seeds, but there was no significant effect of the different types of seeds on the quality of rice grain (weight of 1,000 grains).

As shown in that Table 3, the rice yields were consistently improved by the increases of N concentration in the coating material OMF; and the highest yields were gained by the plants of CS-3, which were about 16.6 kg. $plot^{-1}$ (equivalent to 6,640 kg. $ha^{-1}$). Based on the results, coating the rice seeds with OMF containing about 9% N was a suitable method to optimize production.

## 4. CONCLUSION

The growth components (number of tillers and weight of biomass) and grain quality (weight of 1,000 grains) of the rice plants grown from the non-coated seeds were similar to those for the coated seeds with the N-enriched OMF. On the other hand, adding N up to 9% to the coating material (OMF) improved the grain yield of rice plants from the coated seeds, and the seed coating method was a suitable method to optimize production. By planting the OMF-coated seeds, farmers may gain optimum yield without applying additional fertilizers.

## ACKNOWLEDGEMENTS

The authors thank The Directorate of Higher Education, The Ministry of Research, Technology and Higher Education, The Republic of Indonesia for its financial support for the research.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Hill HJ. Recent development of seed technology. J. New Seeds. 1999;1(1):105-112.
2. Hazra DK, Patanjali PK. Seed coating formulation technologies: an environmental biology friendly approaches for sustainable agriculture. Bioscience Methods. 2016; 7(5):1-10.
3. Arias-Rivas, B. Evaluation of seed coating treatment on maize (*Zea mays*) stands establishment and seed rot caused by

*Pythium* spp. at early planting season. Ph.D. Thesis. Iowa State University; 1994.

4. Castañedaa LMF, Genroa C, Roggiaa I, Bendera SS, Benderb RJ, Pereiraa CN. Innovative rice seed coating (*Oryza sativa*) with polymer nanofibres and microparticles using the electrospinning method. J. Res. Updates in Polymer Sci. 2014;3(1):33-39.
5. Samac DA, Schraber S, Barclay S. A mineral seed coating for control of seedling diseases of Alfalfa suitable for organic production systems. Plant Diseases. 2015; 99(5):614-619.
6. Reus HAM, Glas J. Seed coating composition. Patent WO 2010107312 A1; 2010
7. Sharma KK, Singh US, Sharma P, Kumar A, Sharma L. Seed treatments for sustainable agriculture – a review. J. Applied and Nat. Sci. 2015;7(1):521-539.
8. Epstein E. Silicon. Annu. Rev. Plant Physiol. Plant Mol. Biol. 1999;50:641–664.
9. Biel K, Matichenkov V, Fomina I. Role of silicon in plant defensive system. In: Keeping (Ed.). Silicon in agriculture conference, South Africa. 2008;28.
10. Etesami H, Jeong BR. Silicon (Si): Review and future prospects on the action mechanisms in alleviating biotic and abiotic stresses in plants. Ecotoxicol. Environ. Saf. 2018;147:881–896.
11. Priyono J, Gilkes RJ. Application of silicate rock fertilizers improves plant growth: A glasshouse assessment. Comm. Soil and Plant Anal. 2008;39:358–369.
12. Ali A, Basra SMA, Hussain S, Iqbal J, Bukhsa MAAH, Saewar M. Salt stress alleviation in field crops through nutritional supplementation of silicon. Pakistan J. Nutr. 2012;11(8):637-655.
13. Bennett WF. Plant nutrient utilization and diagnostic plant symptoms. In: Benett WF (Ed.). Nutrient deficiencies & toxicities in crop plants. APS Press, the American Phytopathological Society, St Paul Minnesota; 1993.
14. Gorim L, Asch F. Seed coating increases seed moisture uptake and restricts embryonic oxygen availability in germinating cereal seeds. Biology. 2017; 6(31):1–14.
15. Priyono J, Sudharmawan AAK. Seed coating with organomineral fertilizer, an alternative method to improve the efficiency of farming. Asian R. J. Agr. 2020;12(1):12-17.



*Peer-review history:*
*The peer review history for this paper can be accessed here:*

SD Publisher Group
Publisher of peer reviewed international journals, books and monographs

F. No. SDI/ ARJA/22/17822
Dated 18th Oct 2022

**Subject: Final decision of review process for (Manuscript Number. 2022/ARJA/92976) submitted in Asian Research Journal of Agriculture**

**Dear Colleague,**

We are pleased to inform that peer review process and editorial review process have been completed for your following manuscript

**Manuscript Number: 2022/ARJA/92976**

**Title: The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer**

**Author(s): Joko Priyono, Anak Agung Ketut Sudharmawan**

We are ready with the final decision. We are happy to inform you that your manuscript is officially accepted for publication in Asian Research Journal of Agriculture

Once your manuscript is moved to publishing, our production editor will keep you informed of your article's progress in the production process. You will also receive a galley proof of your manuscript for final review. We're excited to move forward with your submission. Please feel free to email me with any questions.

Thank you for submitting your paper.

Publisher Group
India
UK
SD

**Thanking you.**

MBasu

**Dr. M. Basu**
Chief Managing Editor

Certificate No: PUB. 2022/ARJA/92976

# Asian Research Journal of Agriculture

## Certificate of Publication

**Manuscript Title:** The Agronomic Performance of Rice Seeds Coated with N-Enriched Organomineral Fertilizer

---

## Authored by:

Joko Priyono and Anak Agung Ketut Sudharmawan

**Published in:**
**2022 - Volume 15 [Issue 4]**
**Date of Publication: 20-Oct-22**
Certificate validation link: https://journalarja.com/index.php/ARJA/article/view/366

Dr. M. Basu
Chief Managing Editor

Reg. Offices:
India: Guest House Road, Street no - 1/6, Hooghly, West Bengal, India, Tele: +91 8617752708
UK: Third Floor, 207 Regent Street, London, W1B 3HH, UK, Fax: +44 20-3031-1429