Effect of liquid organic fertilizer derived from moringa on growth of upland red rice lines crosses from SE Sulawesi

W Nasira¹, R Adawiyah¹, Muhidin¹, G R Sadimantara¹ and D N Yusuf²

¹Department of Agrotechnology, Faculty of Agriculture, Halu Oleo University Kendari, Southeast Sulawesi, 93232 Indonesia
²Department of Soil Science, Faculty of Agriculture, Halu Oleo University Kendari, Southeast Sulawesi, Indonesia, 93232 Indonesia

E-mail : muhidinunhalu@gmail.com

Abstract: Upland rice is an important food crop in Indonesia, including in Southeast Sulawesi, and the productivity still low under the production potential. One of the causes of this low production is low soil fertility and limited nutrients for plants. One of the efforts is by providing liquid organic fertilizer derived from moringa. This study used a two-factor and arranged in a randomized block design (RBD). The first factor was organic fertilizer treatment from moringa, consisting of two levels, namely without treatment and 20 ml per liter. The second factor was the difference cultivars tested consisting of 4 cultivars, namely GS44-1, GS44-2, GS16-1, GS16-2, and Lipigo 4. The results showed that the treatment of liquid organic fertilizer made from moringa significantly effects on the on the plant height, number of leaves and number of tillers on upland red rice.

1. Introduction
Rice is still the dominant staple food in Indonesia and demanding every year increase [1]. Rice is mainly not only a source of carbohydrate and energy but also as functional food in the form of red rice and source of antioxidants [2-3]. Antioxidant contain anthocyanins [4] and very important for the human body [5]. As a functional food, red rice must be produced in a healthy and environmentally friendly manner [6]. The need for rice, including red rice, is always increasing. Various attempt have been made to maintain rice production, starting from improving the quality of seeds [7-8] in the upstream sector, improving cultivation techniques, developing upland rice system [9-13], even developing new cultivars through crossbreeding [14-17], mutation breeding [18] and developing hybrid rice [19-20].

Mostly for red rice, because it functions as a functional food, the technique being developed is a model of organic plant cultivation by making the most of organic fertilizers and reducing the use of inorganic fertilizers. Farmers often use inorganic fertilizers because the results are quickly visible [21]. Excessive and continuous inorganic fertilizers can reduce soil health and are less environmentally friendly [22-24].

One method in developing organic agriculture is the use of organic fertilizer that has enriched with rhizobacteria such as Pseudomonas, Azotobacter, and Azospirillum [25-31]. These bacteria function as plant growth promoters of rhizobacteria. Some other materials used as a source of mineral nutrients are extracts of plant material developed in liquid fertilizer using moringa. Moringa is known as a plant
that can grow on suboptimal land. Besides, moringa has a high mineral content and has known as a food source in several countries, including Indonesia.

Several studies have shown that moringa leaf extract can increase growth and production in snap beans [32], cowpea [33], solanum [34], maize [35], okra [36] and pakcoi [37]. Application of moringa leaf extract can also improve the growth of pepper seeds [38], increase plant resistance to drought [39], growth biostimulant [40], and growth enhancer [41]. This study aims to determine the effect of giving moringa extract in the form of liquid organic fertilizer (LOF) on rice vegetative growth.

2. Materials and methods
The research was conducted at the Experimental Garden, Department of Agrotechnology, Faculty of Agriculture, Halu Oleo University. This study used a two-factor factorial randomized block design (RBD). The first factor was the treatment of organic fertilizers from moringa, consisting of a level, namely without treatment and 20 ml L\(^{-1}\) treatment. The second factor is the difference in cultivars used. The cultivars are the result of crossing local superior upland red rice with lowland rice. The cultivars used are GS44-1, GS44-2, GS16-1, GS16-2, and Lipigo4 as control cultivar.

3. Results and discussion
3.1. Plant height
Results of analysis of variance showed that the treatment of moringa LOF and cultivar differences significantly affected plant height (table 1 and 2). Moringa LOF has a significant effect only at 28 DAP. After that, the application of moringa LOF did have a significant effect on plant height.

| Treatment | Plant height (cm) |
|-----------|------------------|
|           | 14 DAP | 28 DAP | 42 DAP | 56 DAP | 70 DAP |
| P0        | 25.17   | 48.19a  | 66.88  | 78.37  | 74.75  |
| P1        | 24.32   | 53.76b  | 67.56  | 77.75  | 80.25  |

The different cultivar significantly affects the plant height from the first observation on 14 DAP until the last observation on 70 DAP.

| Treatment | Plant height (cm) |
|-----------|------------------|
|           | 14 DAP | DMRT\(_{0.05}\) | 28 DAP | DMRT\(_{0.05}\) | 70 DAP | DMRT\(_{0.05}\) |
| GS44-1    | 27.02b  | 2 = 3.40  | 55.99b  | 2 = 5.60  | 88.66a  | 2 = 9.81  |
| GS44-2    | 25.91b  | 3 = 3.55  | 52.19b  | 3 = 5.85  | 93.89a  | 3 = 10.24 |
| GS16-1    | 26.78b  | 4 = 3.64  | 53.05b  | 4 = 5.99  | 91.71a  | 4 = 10.49 |
| GS16-2    | 27.83b  | 5 = 3.71  | 54.96b  | 5 = 6.10  | 94.88a  | 5 = 10.68 |
| Lipigo4   | 16.18a  | 36.68a    | 111.71b |          |         |          |

Note: The numbers followed by different letters in the same column are significantly different at the 95% confidence level. DAP = Days after planting.

Based on table 2, it is seen that the lowest plant heights were obtained in the Lipigo 4 cultivar, especially at the ages of 14 and 28 DAP, which reached 16.18 cm and 36.68. However, towards the end of the study, the control plants were higher than the plants tested. There is no significant
difference in plant height from the beginning of the study to the final phase of the vegetative research. Based on the DMRT test, it appears that there is no significant difference in plant height between the lines tested, namely the GS44-1, GS44-2, GS16-1, and GS16-2 lines.

3.2. Leaf number
Results of analysis of variance showed that the treatment of moringa LOF and cultivar different significantly affected leaf number (tables 3 and 4). Moringa LOF has significant leaf numbers at 42, 56, and 70 DAP. The results showed a significant difference in the number of leaves due to the treatment of liquid organic fertilizer sourced from moringa.

Table 3. Effect of moringa liquid organic fertilizer on upland rice leaf number.

| Treatment | 42 DAP | 56 DAP | 70 DAP |
|-----------|--------|--------|--------|
| P0        | 5.67a  | 9.37a  | 19.03a |
| P1        | 7.07b  | 11.03b | 22.87b |
| DMRT0.05  | 2 = 2.07 | 2 = 2.69 | 2 = 5.92 |

Based on table 3, it appears that the difference in cultivars has a significant effect on the number of leaves of cross-bred cultivars.

Table 4. Effect of different cultivar on upland rice leaf number.

| Treatment | 14 DAP | 28 DAP | 56 DAP | 70 DAP |
|-----------|--------|--------|--------|--------|
| GS44-1    | 2.58b  | 3.08a  | 8.58a  | 16.83a |
| GS44-2    | 3.08c  | 3.67b  | 9.83a  | 19.33a |
| GS16-1    | 2.25b  | 3.75c  | 10.17a | 20.67a |
| GS16-2    | 2.58b  | 3.17a  | 8.83a  | 18.42a |
| Lipigo 4  | 1.75a  | 3.25a  | 13.58b | 29.5b  |
| DMRT0.05  | 2 = 0.37 | 2 = 0.45 | 2 = 2.69 | 2 = 5.92 |
|           | 3 = 0.39 | 3 = 0.47 | 3 = 2.81 | 3 = 6.18 |
|           | 4 = 0.40 | 4 = 0.49 | 4 = 2.88 | 4 = 6.33 |
|           | 5 = 0.41 | 5 = 0.50 | 5 = 2.93 | 5 = 6.45 |

DAP = Days after planting.

Based on table 4, it's seen that the lowest number of leaf were obtained in the Lipigo 4 cultivar, especially at the ages of 14 and 28 DAP. The research also showed a significant difference in leaf number from the beginning of the study to the final phase of the vegetative research. Based on the DMRT test, it appears that there is no significant difference in leaf number between the lines tested, namely the GS44-1, GS44-2, GS16-1, and GS16-2.

3.3. Number of tiller
Results of variance analysis showed that moringa LOF treatment has a significant effect on a tiller number (table 5). Data in table 5 showed that moringa's application had had a significant effect on the
number tiller at 42 DAP and 56 DAP. The number tiller on a plant that gets treatment with moringa has a higher number of tiller than that without moringa.

Table 5. Effect of moringa liquid organic fertilizer on the explanation related to red rice in the background of the study is not illustrated in the title rice number tiller.

| Treatment | Average of tiller number | 42 DAP | 56 DAP | 70 DAP |
|-----------|--------------------------|--------|--------|--------|
| P0        | 1.13a                    | 2 = 0.48 | 1.70a | 2 = 0.63 |
| P1        | 1.77b                    |        | 2.23b |        |

The result also showed that the different cultivar has a significant effect on number tiller (table 6). The difference in the number of tillers occurred between the seeding lines (Lipigo) and the GS44-1 crossed test lines, GS44-2, GS16-1 and GS16-2. Meanwhile, the number of tillers in the lines tested generally did not significantly differ in the number of tillers from the first observation to the last observation at 74 DAP.

Table 6. Effect of different cultivar on tiller number

| Treatment | Number Tiller | 42 DAP | 56 DAP | 70 DAP | 72 DAP |
|-----------|---------------|--------|--------|--------|--------|
| GS44-1    | 1.42a         | 2 = 0.48 | 1.58a | 2 = 0.63 | 4.17a |
| GS44-2    | 1.25a         | 3 = 0.51 | 1.92a | 3 = 0.66 | 3.75a |
| GS16-1    | 1.42a         | 4 = 0.52 | 1.83a | 4 = 0.67 | 4.25a |
| GS16-2    | 1.25a         | 5 = 0.53 | 1.75a | 5 = 0.68 | 4.00a |
| Lipogo 4  | 1.92b         | 2.75b   |        | 6.17b  |        |

4. Discussion
In general, it appears that the treatment of moringa fertilizer has a significant effect on plant height, the number of leaves and a number of tillers. The treatment has a significant effect, especially in the early stages of vegetative growth. However, with the increasing age of the plants and towards the end of the vegetative phase, the treatments tested tended to have no significant effect on plant height, the number of leaves, and a number of tillers. The difference in cultivars significantly affected plant height, number of leaves, and number of tillers. There was a significant difference between the Lipigo comparison cultivar and the new cross lines tested, namely GS44-1, GS44-2, GS16-1 and GS16-2. Meanwhile, there were no significant differences in plant height in the new crossed lines number of leaves, and number of tillers from the first observation to the last observation at 74 DAP. In general, moringa extract contain lots of vitamins and minerals [37] that can be used to accelerate plant vegetative growth.

5. Conclusion
Based on the research that has been done, it can be concluded that the application of organic fertilizers from moringa has an effect on plant height, number of leaves and number of tillers resulting from new crosses GS44-1, GS44-2, GS16-1 and GS16-2.

References
[1] Muhidin 2015 *Morphological Characterisation and the Quality of Red Rice Irradiated with*
Gamma Rays in Various Kinds of Shade and the Application of Bacterial Fixation in Dry Land in Southeast Sulawesi (Makassar: Hasanuddin University)

[2] Shao Y and Bao J 2015 Polyphenols in whole rice grain: Genetic diversity and health benefits Food Chem. 180 86–97

[3] Shao Y, Xu F, Sun X, Bao J and Beta T 2014 Identification and quantification of phenolic acids and anthocyanins as antioxidants in bran, embryo and endosperm of white, red and black rice kernels (Oryza sativa L.) J. Cereal Sci. 59 211–8

[4] Gunaratne A, Wu K, Li D, Bentota A, Corke H and Cai Y-Z 2013 Antioxidant activity and nutritional quality of traditional red-grained rice varieties containing proanthocyanidins Food Chem. 138 1153–61

[5] Bhat F M and Riar C S 2015 Health benefits of traditional rice varieties of temperate regions Med. Aromat. Plants 4

[6] Sutariati G A K, Bande L O S, Khaeruni A, Muhidin, Mudi L and Savitri R M 2018 The effectiveness of preplant seed bio-invigoration techniques using Bacillus sp. CKD061 to improving seed viability and vigor of several local upland rice cultivars of Southeast Sulawesi IOP Conf. Ser. Earth Environ. Sci. 122

[7] Sutariati G A K, Muhidin, Rakian T C, Afa L O, Made Widanta I, Mudi L, Sadimantara G R and Leomo S 2018 The effect of integrated application of pre-plant seed bio-invigoration, organic and inorganic fertilizer on the growth and yield of local upland rice Biosci. Res. 15 160–5

[8] Sutariati G A K, Arif N, Muhidin, Rakian T C, Mudi L and Nuralam 2017 Persistency and seed breaking dormancy on local upland rice of Southeast Sulawesi, Indonesia Pakistan J. Biol. Sci. 20 563–70

[9] Kadidaa B, Sadimantara G R, Suaib, Safuan L O and Muhidin 2017 Genetic diversity of local upland rice (Oryza sativa L.) genotypes based on agronomic traits and yield potential in North Buton, Indonesia Asian J. Crop Sci.

[10] Sadimantara G R, Febrianti E, Suliartini N W S, Sutariati G A K and Yusuf D N 2020 Grain yield and yield attributes response of four upland rice (Oryza sativa L.) promising lines to shade stress E&ES 454 12188

[11] Nuraida W O, Pitra Pradipta R, Sri Suliartini N W, Wijayanto T, Muhidin and Sadimantara G R 2020 Production and quality of upland red rice under the shade stress Int. J. Sci. Technol. Res. 9 5016–9

[12] Muhidin, Syam’un E, Kaimuddin, Musa Y, Sadimantara G R, Usman, Leomo S and Rakian T C 2018 Shading effect on generative characters of upland red rice of Southeast Sulawesi, Indonesia IOP Conference Series: Earth and Environmental Science vol 157 p 012017

[13] Muhidin, Syam’un E, Kaimuddin, Musa Y, Sadimantara G R, Usman, Leomo S and Rakian T C 2018 The effect of shade on chlorophyll and anthocyanin content of upland red rice IOP Conf. Ser. Earth Environ. Sci. 122 012030

[14] Sadimantara G R, Muhidin, Sri Suliartini N W, Nuraida W, Sadimantara M S, Leomo S and Ginting S 2018 Agronomic and yield characteristics of new superior lines of amphibious rice derived from paddy rice and local upland rice crossbreeding in konawe of Indonesia Biosci. Res. 15 893–9

[15] Sadimantara G R, Alawyah T, Suliartini N W S, Febrianti E and Muhidin 2019 Growth performance of two superior line of local upland rice (Oryza sativa L.) from SE Sulawesi on the low light intensity IOP Conference Series: Earth and Environmental Science vol 260 (IOP Publishing) p 12145

[16] Sadimantara G R, Kadidaa B, Suaib, Safuan L O and Muhidin 2018 Growth performance and yield stability of selected local upland rice genotypes in Buton Utara of Southeast Sulawesi IOP Conference Series: Earth and Environmental Science vol 122

[17] Sadimantara G R, Muhidin, Ginting S and Suliartini N W S 2016 The potential yield of some superior breeding lines of upland rice of Southeast Sulawesi Indonesia Biosci. Biotechnol.
[18] Suliartini N W S, Wijayanto T, Madiki A, Boer D, Muhidin and Tufaila M 2018 Yield potential improvement of upland red rice using gamma irradiation on local upland rice from southeast sulawesi Indonesia Biosci. Res. 13 1867–70

[19] Afa L O, Purwoko B S, Junaedi A, Haridjaja O and Dewi I S 2018 Simulation of hybrid rice tolerance to drought stress on nutrients culture in seedling phase Biosci. Res. 15 530–9

[20] Afa L O, Purwoko B S, Junaedi A, Haridjaja O and Dewi I S 2018 Screening of hybrid rice tolerance through simulated condition of drought stress in rainfed lowland Biosci. Res. 15 1630–7

[21] Chen J, Lü S, Zhang Z, Zhao X, Li X, Ning P and Liu M 2018 Environmentally friendly fertilizers: A review of materials used and their effects on the environment Sci. Total Environ. 613 829–39

[22] Bora R, Pandey P C, Singh D K, Yadav S K and Chilwal A 2018 Assessment of soil fertility status under long term balance fertilizer application on rice (Oryza sativa L.) IJCS 6 1696–9

[23] Sábiha N-E, Salim R, Rahman S and Rola-Rubzen M F 2016 Measuring environmental sustainability in agriculture: A composite environmental impact index approach J. Environ. Manage. 166 84–93

[24] Rahman K M and Zhang D 2018 Effects of fertilizer broadcasting on the excessive use of inorganic fertilizers and environmental sustainability Sustainability 10 759

[25] Syaiful S A, Syam’un E, Dachlan A, Kamaruzaman J and Haerani N 2013 The effect of inoculating nitrogen fixing bacteria on production of rice. World Appl. Sci. J. 26 94–9

[26] Fukami J, Cerezini P and Hungria M 2018 Azospirillum: benefits that go far beyond biological nitrogen fixation AMB Express 8 73

[27] Wani S A, Chand S, Wani M A, Ramzan M and Hakeem K R 2016 Azotobacter chroococcum—a potential biofertilizer in agriculture: an overview Soil Science: Agricultural and Environmental Prospectives (Springer) pp 333–48

[28] Muhidin, Syam’un E, Kaimuddin, Musa Y, Sadimantara G R, Rakian T C, Leomo S and Yusuf D N 2020 Effect of root endophytic diazotrophic azotobacter and azospirillum on the vegetative growth of local upland red rice Int. J. Sci. Technol. Res. 9 3345–8

[29] Muhidin, Syam’un E, Musa Y, Sadimantara G R, Leomo S, Sutariati G A K, Yusuf D N and Rakian T C 2020 Effect dual inoculation of Azotobacter and Azospirillum on the productive trait upland red rice cultivar IOP Conference Series: Earth and Environmental Science vol 575 (IOP Publishing) p 12093

[30] Nurmas A, Anwar, Karimuna L, Sabaruddin L, Khaeruni A and Muhidin 2018 The role of azotobacter sp. In reducing inorganic fertilizer of nitrogen on growth of local maize (zea mays l.) In ultisol Biosci. Res. 15 428–36

[31] Nurmas A, Karimuna L, Sabaruddin L, Khaeruni A, Muhidin, Rahayu M, Hasid R and Adawiyah R 2018 The effectiveness of azotobacter sp. In increasing growth of local maize and sorghum in the intercropping system in ultisols Biosci. Res. 15 1645–4652

[32] Emongor V 2015 Effects of Moringa (Moringa oleifera) Leaf Extract on Growth, Yield and Yield Components of Snap Beans (Phaseolus vulgaris) Br. J. Appl. Sci. Technol. 6 114–22

[33] Maishanu H M, Mainasara M M, Yahaya S and Yunusa A 2017 The Use of Moringa Leaves Extract as a Plant Growth Hormone on Cowpea (Vigna anguiculata) Path Sci. 3 3001–6

[34] Ozobia A P 2014 Comparative assessment of effect of Moringa e xtracts , NPK fertilizer and poultry manure on soil properties and growth performance of Solanum menlongina in Abuja , North Central Region of Nigeria J. Agric. Crop Res. 2 88–93

[35] Williams O A, Ogunwande O A and Amao A O 2018 Potentials of Moringa oleifera Leaf Extract in Increasing Maize (Zea mays L.) Productivity in Nigeria Int. J. Sci. Res. Publ. 8 279–90

[36] Aluko M, Ayodele O J, Gbadeola A S and Oni I H 2017 Comparative effects of Varying Rates of Moringa Leaf, Poultry Manure and NPK Fertilizer on the Growth, Yield and Quality of
Okra (*Abelmoschus esculentus* L. Moench) *Int. J. Environ. Agric. Biotechnol.* 2 2901–7

[37] Sari P N, Auliya M, Farihah U and Nasution N E A 2020 The effect of applying fertilizer of moringa leaf (*Moringa oleifera*) extract and rice washing water to the growth of pakcoy plant (*Brassica rapa* L. spp. Chinensis (L.)) *J. Phys. Conf. Ser.* 1563

[38] El-nour H A and Ewais A 2017 Effect of *Moringa oleifera* Leaf Extract (MLE) on Pepper Seed Germination, Seedlings Improvement, Growth, Fruit Yield and its Quality *Middle East J. Agric. Res.* 6 448–63

[39] Hanafy R S 2017 Using *Moringa olifera* Leaf Extract as a Bio-fertilizer for Drought Stress Mitigation of *Glycine max* L. Plants *Egypt. J. Bot.* 57 281–92

[40] Merwad A-R M A 2018 Using *Moringa oleifera* extract as biostimulant enhancing the growth, yield and nutrients accumulation of pea plants *J. Plant Nutr.* 41 425–31

[41] Abd El-Hack M E, Alagawany M, Elyr S A, Desoky E S M, Tolba H M N, Elnahal A S M, Elnesr S S and Swelum A A 2018 Effect of forage *Moringa oleifera* L.. (moringa) on animal health and nutrition and its beneficial applications in soil, plants and water purification *Agric.* 8 1–22