The response of Inpago 8 rice to the provision of compost and Biochar in dryland

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Abstract. Compost and biochar are organic materials that can improve the function of soil as a growing medium in cultivation. Inpago 8 is a kind of upland rice which is grown in the dry land. This study was conducted to determine the effects of compost and biochar on dryland to the growth and yield of Inpago 8 rice plant. The experiment was conducted on dry land in Natar Experimental Station, South Lampung from January 2015 until May 2015. Six treatments were tested in this study consisted above: (A) control (without compost and biochar), (B) biochar rice husk 5 ton/ha (t/ha), (C) biochar rice husk 10 t/ha, (D) compost 5 t/ha, (E) biochar rice husk 5 t/ha + Compost 5t/ha, and (F) Biochar rice husk 10 t/ha + compost 5t/ha, using a randomized block design with four replications. Observations were conducted on the components of growth and yield of Inpago 8 rice plant, data analysis used Duncan's test. The result showed that the best appearance of the growth and yield of Inpago 8 rice plant is the application of biochar rice husk 5 t/ha + compost 5t/ha.

1. Introduction
Rice as a national staple crop is the main crop consumed by most of the Indonesian people. In order to produce it, various efforts have been done such as extensification and intensification. Basically, rice planting can grow well in wetland or dry land. In some areas that do not have irrigation system, rice cultivation is done on dry land. Efforts to increase rice production in various regions are generally focused on areas or land with irrigation facilities, using wetland rice paddy, where water availability is always available throughout the season [1]. Nevertheless, the production level still does not meet the national needs, there is still insufficiency because of pests and diseases attack, droughts and natural disasters such as floods. In order to anticipate the above conditions, the development of upland rice production in dryland areas needs to be seriously concerned. The average productivity of upland rice is 2.56 ton/ha (t/ha), far below the productivity of wetland rice, which is 457 t/ha. The total of paddy cultivation area in Indonesia is 188.2 million ha and 148 million ha of them is dry land [2]. The potential of dry land in many areas has not been optimally utilized for the development of rice crops. The contribution of upland rice production only reaches 5 – 6 % [3], which categorized as low. The content of sufficient organic matter and nutritional biology cycle is one of the keys to successful dryland management. The addition of mulch, compost or manure often succeeds in improving soil productivity, supplying nutrients to crops, supporting nutrient cycles through microbial biomass and retaining mineral fertilizer, but according to Lehmann and Rondon [4], the response is short, so that organic ingredients must be added each year to maintain land productivity. Giving biochar or black carbon (C) could overcome these limitations for soil management. According to Lehmann [5], Biochar
is more effective to hold nutrients for its availability for plants than organic materials such as compost or manure. Biochar also retains P which can not be retained by ordinary soil organic matter [6]. Generally, biochar application can stay in the ground for hundreds or even thousands of years. In the long run, biochar can hold and make water and nutrients more available to plants [7].

The use of compost and biochar on agricultural land is not only as a nutrient source but also as one of the alternatives to reduce environmental pollution by agricultural wastes around the rice-milling site and an effort to return the rest of the harvest to the agricultural area and support the organic farming program. Another important factor to note is the use of appropriate varieties with the typology of the growing environment [8]. Inpago 8 varieties are one of the new high yielding varieties of rice (New Superior Varieties, NSV), which play an important role in increasing yield per unit area [9]. Numerous studies have been conducted in an effort to increase the production of upland rice in dryland areas, such as the implementation of organic fertilizer [10], legowo planting system [11,12], drought-tolerant rice field [13], weed control systems on upland rice cultivation [14], morphological studies and physiological shade tolerance [15,16], nutrient status due to Fe poisoning on land [17], application of TOT system [18], Al tolerant rice on acid soils [19], and N fertilizer on rice cultivation [20]. However, there has not been much research done by applying compost or biochar on dry land as an effort to increase yield. Therefore this research needs to be done. The purpose of this research is to know the effect of composting and biochar application and its effects on growth and yield of Inpago 8 varieties of rice. This research becomes important to be done as one of alternative farming pattern for farmers in the dryland area in an effort to increase rice production of Inpago 8 varieties.

2. Material and methods

This research was conducted in Natar Research Station – South Lampung, which has a fairly wide dry land about 52 ha [21]. The activities were carried out from January to May 2015. The experimental design used was a Randomized Block Design with 4 (four) replicates. The treatments were applying the combination of compost and rice husk Biochar to the rice fields with the variety of Inpago 8. The combination of the treatments were: A (without compost and biochar, as control/comparison), B (rice husk Biochar 5 t/ha), C (10 t/ha of rice husk Biochar), D (5 t/ha of Compost), E (5 t/ha of Compost + 5 t/ha of rice husk Biochar), and F (5 t/ha of Compost + 5 t/ha of rice husk Biochar). The experimental unit used was 200 m² and the number of seeds planted was 2-3 seeds each hole with 2:1 legowo cropping system. Specific spot fertilization was done with 200 kg urea, 150 kg SP36, and 100 kg KCl per ha. Control of plant pest organisms (OPT) was carried out as needed with the guidance to the concept of Integrated pest and disease control (IPC). Supporting tools used in this study include hand counter, cutter, meter, scales, hoes, and plastic for sampling.

The data was collected to observe the growth of plant height which was underwent at the end of vegetative plant (about two months after planting, before the flowering stage). The observations included the number of productive tillers and rice yields at harvest (the number of grains per panicle, the number of empty grains per panicle, and the yield of dry grain harvest per ha). Measurement and observation of plant height and number of productive tillers are taken from the same samples, each plot is taken as many as 10 clump samples. Plant height is measured from the base of the plant from the surface of the soil to the highest shoot by using the meter. The number of productive tillers is calculated directly in the field visually using hand counter, also the number of grains per panicle, and the number of empty grain per panicle. And then the weight of the grain yield was weighted to know the yield of dry grain harvest per hectare. The data were analyzed by analysis of variance (ANOVA), and continued by Duncan test [22] to determine the difference in the treatment under test.
3. Results and discussion

3.1. Plant Growth.
Data on plant height growth and the number of productive tillers are presented in Table 1. Inpago 8 varieties response to composting and biochar showed that the average plant height is above 100 cm and the average number of productive tillers is about 12 crops per clump. The highest crops shown in control plants (without compost and biochar) were 118.4 m, not significantly different from those treated with 5 ton/ha biochar rice husk (B), 10 ton/ha rice husk (C), and 5 ton/ha Compost + 10 ton/ha biochar rice husk (F), lowest is 5 ton/ha of compost + 5 ton/ha biochar husk rice (F) that is 109.88 cm, but this treatment gives the highest number of productive tiller that is 14 Stems per clump (Table 1). According to Suwarno et al. [23], there is an interaction between Inpago 8 varieties growth with good and appropriate environment, so with 5 ton/ha of compost + 5 ton/ha, biochar rice husk gives the best growth. The paragraph text follows on from the subsubsection heading but should not be in italic.

Table 1. Rate the growth of plant height and number of productive tillers of rice Against some compost and biochar treatments

| Treatment                  | Number of tillers per clump | Number of tillers |
|----------------------------|-----------------------------|-------------------|
| A= control (without compost and biochar) | 118.40 a | 13.25 ab |
| B= biochar 5t/ha           | 115.08 ab | 12.75 ab |
| C= biochar 10 t/ha         | 117.40 a | 12.5 b |
| D=compost 5t/ha           | 111.00 b | 12.00 b |
| E= kompos 5t/ha+biochar 5t/ha | 109.88 b | 14.00 a |
| F= kompos 5t/ha+biochar10t/ha | 114.80 ab | 12.75 ab |

Note: The number assigned to the same superscript letter/s, there is no significant difference with Duncan Test at 5% real level.

3.2. Rice Yield
Inpago 8 rice responses to the biochar and compost treatment that produced the highest dry harvested rice were the treatment of biochar combination of rice husk 5 ton/ha + 5 ton/ha compost, significantly different from the compost only treatment 5t/ha, and control (without biochar and compost) (Table 2). This shows that the combined treatment of rice husk biochar with dose of 5 ton/ha + compost of 5 ton/ha is the optimum and the best dose compared to other treatments because it gives the highest average yield of dry paddy grain which is 5.37 t/ha, and the lowest number of empty grains per panicle (Table 2). Chan et.al. [24] in Manaus Brazil also showed that the biochar combination treatment and compost from forage waste increased agricultural yields. According to Gadde et.al. [25], biochar rice husk is the most potential and more effective in nutrient retention and availability for plants. Provision of biochar to the soil increases the availability of cations, P and the total N concentration in soil, CEC and pH increases to 40% of the initial CEC and up to one pH unit. The high availability of nutrients for crops is the result of the direct increase of nutrients from biochar and nutrient retention [7,24,26]. The addition of biochar dosage will appear visible positive effect on the enhancement of crop yields at a longer time. Therefore in this research, the addition of biochar dose from 5t/ha to 10 t/ha was not significantly different from other treatments. Although Inpago 8 rice cultivation in the experiment was conducted in dry land, with combined biochar treatment 5t/ha + 5 t/ha compost, the average yield of dry harvested grain per ha reached 5.37 t/ha which is higher than the average produced according to
the description of NSV of rice [9]. It means in addition to the genetic varieties of Inpago 8, the effect of compost and biochar treatment significantly affect the increase of rice production.

**Table 2.** Average number of grains per panicle, number of empty grain per panicle, and yield of harvested dry grain per ha of Inpago 8 rice for some treatments using compost and biochar

| Treatment                      | Number of tillers per clump | Number of tillers | Grain Yield (t/ha) |
|-------------------------------|------------------------------|-------------------|--------------------|
| A= control (without compost and biochar) | 145,75 c                      | 32,00 ab          | 4,86 bc           |
| B= biochar 5 t/ha              | 163,50 b                      | 34,00 ab          | 5,16 abc          |
| C= biochar 10 t/ha             | 177,25 ab                     | 36,25 a           | 5,18 ab           |
| D= compost 5 t/ha              | 180,00 ab                     | 32,00 ab          | 4,67 c            |
| E= kompos 5 t/ha + biochar 5 t/ha | 192,75 a                     | 27,25 b           | 5,37 a            |
| F= kompos 5 t/ha + biochar 10 t/ha | 177,00 ab                    | 31,75 ab          | 5,06 abc          |

Note: The number assigned to the same superscript letter/s, there is no significant difference in Duncan Test at 5% real level.

4. Conclusions
The results that can be concluded from this study is that the treatment of 5t/ha of Compost + 5t/ha of Biochar was the best combination that could be applied to the cultivation of Inpago 8 rice. It showed the highest of productive tillers growth and harvest yield of dry grain compared to other treatments. It is expected that the results of this study can be used as an alternative pattern of cultivation for farmers in dryland areas in an effort to increase rice production of Inpago 8 varieties.

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References
[1] Jaleel C A, Manivannan P, Wahid M. (2009) Drought stress in plant. A. Review on morphological characteristics and pigments composition int. J. Agric.biol.11: 100-105.
[2] Mulyani A. (2013) The development potential of dry land sour. Center for land resources. Bogor.18p.
[3] Puslitbangtan. (2010) Opportunities towards sustainable rice self-sufficiency. Bogor. 19p
[4] Lehmann J, Rondon M. (2006) Biochar soil management on highly weathered soils in the humid tropics. 517-530p. In taylor & francis group, norman uphoff Eds. Ga 30384-9267
[5] Lehmann J. (2007) Bioenergy in the balack fronters in ecology and the environtment. 5: 381-387
[6] Lehmann J, Gaunt J, Rondon M. (2006) Biochar sequestration terrestrial ecosystems a-review mitigation and adaptation strategic for global change. 11: 403-427
[7] Haeffe S M, Knoblauch C, Benefit A A. (2008) Biochar in rice-based systems: effects and opportunities, biofuels research in the cgvir-a perspective from the science council. Rome italy cgvir science secretariat.
[8] BB Padi. (2008) Rice research program; http://id.wiki/padi. Indonesian center for rice research. Sukamandi
[9] Balitbangtan. (2015). Description nof new superior variety of rice. *Agriculture ministry.* Jakarta. 77 p

[10] Hartati, Suwarto. (2004) Results and quality of superior harvesting of upland rice planted with bio-fertilizer treatment. *Agronomics.* 4 (1): 1-9.

[11] Budiastuti S. (2003) Development of dryland farming according to the concept of environmental sustainability and agricultural land resource development. University of indonesian, jakarta.

[12] Pahrudin A, Maripul, Philips R D. (2004) Legowo planting of paddy as the supports farming system in bojong cikembar village sukabumi. *Engineering bulletin.* 9 (1): 10-12.

[13] Farid N. (2004) Physiology study of drought tolerance in upland rice. *J.agrin.* 8 (2): 108-116.

[14] Aldi M A, Darjanto, Totok A D H. (2004) Effect of weed control on yield of four cultivars of upland rice. *J. Agrin.* 8 (2): 100-1007

[15] Suprayogi, Hidayat P. (1997) Response of upland rice varieties to changes in light intensity and identification of tolerance character of tolerance to shade. Report of research result of apbn project young researcher of dikti, jakarta.

[16] Suwarto, Farid N. (2007) Study of several morphological and physiological characters of five shade tolerant rice varieties. *Agronomics.* 4 (1): 49-58.

[17] Makarim A K, Sudarman O, Supriadi H. (2009) The status of paddy nutrients in Fe toxicity in the batumarta area of Ssouth Sumatra. *Agricultural research.* 9 (4): 166-170.

[18] Supartoto, Widiatmoko T, Haryanto. (2008) Effect of tolet, weeding intensity and dose of n fertilizer on growth and yield of upland rice. Report of research result of spp / dpp unsoed. Purwokerto. 38 p

[19] Suwarto. (2007) Appearance of pure strains of gogo tolerant al rice on acid mineral soils. *Agronomics.* 1 (1): 39-50.

[20] Farid N, Suprayogi. (2007) Efficiency of n on tolerant drought tolerant rice. *Agronomika.* 1 (1): 39-50.

[21] Bptp Lampung. (2013) Report of activities at natar-lampung experimental garden. Final lampung agricultural technology assessment institute. 72p.

[22] Gomez K A, Gomez A A, (1995) Statistical procedures for agricultural research. Translation of university of Indonesia.

[23] Suwarno, Harahap Z, Siregar H. (2004) Interaction of environment varieties in rice production experiment. *Penellitan pertanian.* Bogor. 4 (2) 34 – 39

[24] Chan K, Van Zwenten Y L, Meszaros I, Et Al. (2007) Agronomic values of greenwaste biochar as a soil amandment. *Australian J. of soil res.* 45 (8): 629-634.

[25] Gadde B, Menke C, Siemens W. (2007). *International rice research notes* 32 (2): 5-14.

[26] Chan K, Van Zwenten Y L, Meszaros I. (2008) Using poultry litter biochar as a soil amandments. *Australian J.of soil res.* 46 (5): 437-444.