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Soil Fertility and Rice Biomass Production of Organic Farming System in Termas Village Sragen Regency

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Abstract.

In many cases the yield and quality of organic rice farming system are better than semi organic and conventional rice farming systems; so many farmers want to move to organic rice farming system. The aim of the study was to evaluate soil fertilities and yield of rice biomass under organic system. The study was conducted in organic rice farming system in Termas Village, Sambung Macan Sub District, Sragen Regency from March 2019 to the end of June 2019. Soil was sampled in March 2019 at organic rice farming system. Composite soil samples were collected from ten sampling points and mixed. These samples were analysed for soil fertilities properties. The results indicated that in general the soil fertility under organic rice farming was superior including pH, C-organic, N total, P and K extracted with HCl 25 %. The same result was found in rice biomass production namely rice grains yield (12.68 tons $ha^{-1}season^{-1}$), rice straws (7.25 tons $ha^{-1}season^{-1}$) and rice residues (4.15 tons $ha^{-1}season^{-1}$).

Keywords: soil fertility, rice organic farming

1. Introduction

Rice, vegetables and fruits are not only crop with high economy value, but also source of income providing jobs for most villagers. The farmers also realize that Green Revolution technology, combination between high external inputs (fertilizer and pesticides) and high yielding varieties, is not sustainable, production cost become more expensive and rice production tend to decrease. Therefore, some farmers want to move to other rice farming systems, some want to change to organic farming system, some to semi organic and the rest still doing conventional system with some improvement (Sukristiyonubowo *et al.* 2018a; b). The term of organic refers to a process that uses methods respectful of the environment, from production stages through the handling and processing. Organic farming is not only concerned with the product, but also the whole system used to produce and deliver the product to the ultimate consumers (Anonymous 2004).

Recently, research in organic farming systems have been developed both in plot, farm and community scales with different purposes. Some researchers from different countries have mentioned the advantages doing organic rice, vegetables and fruits including in the soil, quality and quantity of yields and income. According to Sukristiyonubowo *et al.* (2018) soil chemical-physical fertilities in organic field in Kopeng Village, Semarang Regency, was more superior than in conventional vegetables farming system including soil pH, C organic and N, P and K total, bulk density, particle density, soil porosity and permeability (slow and fast drainage). In Bogor Regency, the soil chemical, physical and biological properties of organic vegetable farming are better than conventional farming systems in term of soil pH, organic C, total N, P, and K extracted with HCl 25%, bulk density and dehidrogenase enzyme (Sukristiyonubowo *et al.* 2015). Similar results was reported in rice farming in Sambiredjo Sub District, Sragen Regency, the soil chemical-physical fertility in organic field in Sambiredjo Sub District, Sragen Regency, was more superior than both in semi organic and conventional and in semi organic was better than in conventional system in terms of soil pH, organic C and N, P and K total, bulk density, particle density, soil porosity and permeability. The similar finding was also observed in rice biomass production (Sukristiyonubowo *et al.* 2018). Furthermore, Prakhas *et al.* (2002) reported that rice planted in organic technology has better in milling and cooking quality like total and head milled rice recovery, protein content, kernel elongation and lower in amylose content than cultivated inconventional system with commercials fertilizers and pesticides. Zhang and Shao (1999) reported that higher protein grains content will result in higher head rice recovery and lower amylose content. Chino *et al*. (1987) found that in the organic cultivation, the asparagine's content of plant phloem sap is significantly lower than in conventional systems. Kajimura *et al*. (1995) reported that the low densities of B*rown Plant Hopper* and White Backed Plant Hopperare observed in organic fields. Similar finding was reported by Alice *et al.* (2004). In line with the soil, organic farming is usually associated with a significant higher level of biological activities and soil organic matter than in green revolution technology (Oehl *et al*. 2004; Mader *et al.* 2002; Hansen *et al*. 2000; Stolze *et al.* 2002). In fact, there are still limited studies on comparing organic versus conventional systems (Hasegawa *et al.* 2005).

The aimed of this research was to study the soil fertility and rice biomass production under organic rice farming system in Termes Village, Sambung Macan Sub District, Sragen Regency.

2. Methodology

The experiment was conducted at Vertisols Sambung Macan Sub District of Sragen Regency for conventional, semi organic and organic rice farming systems from March to June 2019. In organic rice farming they apply only organic fertilizer as much as 3 tons ha^{-1} every cropping season. In Sragen Regency, they start organic rice farming systems since 1999.

Composite soil samples of 0-20 cm in depth were taken in March 2019, before soil preparation and submitted to the laboratory of AIAT (Assessment Institute for Agricultural Technology) in Jogyakarta for analysing. One kg soil composite was collected from ten sampling points at every site and mixed. These samples were submitted to the Soil Analytical Laboratory of the Jogyakarta Assessment Institute for Agricultural Technology for analyses of chemical properties of the soils. Chemical analyses included the measurement of pH (H_20, organic matter, phosphorus, and potassium, Organic matter was determined using the Walkley and Black method, pH (H_2O and KCl) was measured in a 1:5 soil-water suspension using a glass electrode, total P and soluble P were measured colorimetrically, extracted using HCl 25% and Olsen methods, respectively. The total K was extracted using HCl 25% and subsequently determined by flame-spectrometry (Soil Research Institute, 2009).

3. Results And Discussion

3.1. Soil Fertility

The soil fertility of the organic rice farming is presented in Table 1. Generally in 2019, the soil pH of the organic rice farming was 6.65 and classified as neutral. The neutral of the soil in organic rice farming may be due to continues appliying manures as much as 3 tons ha^{-1}. Meanwhile, the level of soil organic carbon (SOC) was 2.90 % and classified as height in organic rice farming and higher than in conventional rice farming (1.72%) and semi organic (2.17 %) systems (Sukristiyonubowo *et al* 2019). According to Sommerfeldt et al. (1988) and Clark et al. (1998), they stated that the higher soil Organic Matter levels in soils managed with animal manure and cover crops than in soils without such inputs. Increasing of soil organic carbon (SOC) will be easily soil to be plough. The total N in organic fields was 0.22 % and clasified as medium. This was happened due to addition of organic material (manure and compost). In year 2019, the CEC in organic fields was 31.67 cmol/kg and considered as medium to high. This due to the farmers applied different in organic materials and different in rates (manure and straw compost) that can build the colloids.

Table 1. The soil chemical fertility under organic rice farming systems in Termas Village Sambung Macan, Sragen Regency

Parameters	Organic rice farming
$pH_{(H20)}$	6.65
C-Organic (%)	2.90
N-Total (%)	0.22
P extracted with 25% HCl	184
K extracted with 25% HCl	180
CEC (cmol/kg)	31.67

In organic rice farming system, P extracted with HCl 25% classified as very height, suggesting that application of 3 tons manure ha^{-1} season^{-1} in organic system can increase the availability of P. Total K in rice organic farming was considered very high, higher than in semi organic and conventional farming systems, indicating that application of 3 ton organic materials (manure and straw compost) was enough to increase the total K in the soil. It was suggesting that straw compost applied was rich in K content. Clark *et al.* (1998); Rasmussen and Parton (1994) and Wander *et al.* (1994) also reported similar findings. Therefore, it may be concluded that in general in 2019 the rice organic farming was considered better including pH, C-organic, nitrogen content, and P, and K extracted with 25 % HCl.

3.2. Rice Biomass Production

Rice biomass production of organic farming at Termas Village, Sragen Regency was presented in Table 2. In 2019, according to the farmer organic rice farming system showed the highest rice biomass productions namely rice residues, rice straw, and rice grains productions. Furthermore, the organic rice system also showed the highest income. This due to environmental factors were abundant (there was enough water and abundant sunlight), so photosynthesis took place optimally and photosynthesis results (carbohydrate) was generated a lot. The rice biomass production reached about 4.15, 7.25 and 12.68 $ha^{-1}season^{-1}$ for rice residues, rice straw and rice grains, respectively (Table 2). This was also due to the soil quality including soil chemical, physical and biological fertilities in organic cultivation were getting better and C-organic was getting higher.

Table 2. Rice biomass production of organic and conventional farming systems at Termas Village, Sambung Macan Sub District, Sragen Regency, Central Java Province

Rice Farming	Rice Biomas Productions (tons ha^{-1} $season^{-1}$)		
	Rice Grains	Rice Straws	Rice residues
Organic rice farming	12.68	7.25	4.15
Coventional rice farming	7.00	6.25	3..15

4. Conclusions

In general, in 2019 the soil fertility under organic rice farming was excellent including pH, C-organic, N total, P and K extracted with HCl 25 %. The same result was happened in rice biomass production namely rice grains yield (12.68 tons ha^{-1} $season^{-1}$), rice straws (7.25 tons ha^{-1} $season^{-1}$) and rice residues (4.15 tons ha^{-1} $season^{1}$).

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References

Alice, J, Sujeetha, R.P. and Venugopal, M.S. 2003. Effect of organic farming on management of rice brown plant hopper. IRRN. 28 (2): 36 – 37

Anonymous. 2004. The promise of organic farming. FFTC News Letter 146.

Chino, M., Hayashi, M. and Fukumorita, T. 1987. Chemical composition of rice phloem sap and its fluctuation. J. Plant Nutr 10: 1651-1661.

Clark, M.S, Horwath, W.R, Shennan, C. and Scow, K.M. 1998. Changes in soil chemical properties resulting from organic and low-input farming practices. Agronomy Journal. 90: 662-671.

Cho, J.Y., Han K.W., Choi, J.K., Kim, Y.J. and Yoon KS. 2002. N and P losses from paddy field plot in Central Korea. Soil Science and Plant Nutrition. 48: 301-306.

Hansen, B., Kristensen, E.S., Grant R., Hogh, Jensen H., Simmelsgaard, S.E. and Olesen J.E. 2000. Nitrogen leaching from conventional versus organic farming systems- a system modelling approach. European Journal of Agronomy. 13:65–82.

Haynes, R.J. 2005. Labile organic matter fractions as central component of the quality of agricultural soil: an overview. Adv Agron 85: 221 - 268

Hasegawa, H., Furukawa, Y. and Kimura, S.D. 2005. On-farm assessment of organic amendments effects on nutrient status and nutrient use efficiency of organic rice fields in Northern Japan. Agriculture, Ecosystems and Environment. 108:350-362.

Herrick, J.E. 2000. Soil Quality: An indicator of sustainable land management. Applied Soil Ecology 15: 75 - 83

Kajimura, T., Fujisaki, K. and Nagasuji, F. 1995. Effect of organic rice farming on leafhoppers and plant hoppers and amino acid contents in rice phloem sap and survival rate of plant hoppers. Applied Entomology Journal. 30:12–22.

Landa, J.K, Pareek, R.P. and Becker, M. 1992. Stem-nodulating legume-Rhyzobium symbiosis and its agronomic use in lowland rice. Springer, New York.

Mäder, P., Fliessbach, A, Dubois, D., Gunst, L., Fried P and Niggli U. 2002. Soil fertility and biodiversity in organic farming. Science, 296, 1694-1697.

Mandal, Uttam K., Singh G., Victorm, U.S. and Sharma, K.L. 2003. Green Manuring: its effect on soil properties and crop growth under rice-wheat cropping system. European Journal of Agronomy. 19: 225-237

Oehl, F., Sieverding E., Mäder, P, Dubois, D., Ineichen, K., Boller, T.and Wiemken, A. 2004. Impact of long-term conventional and organic farming on the diversity of arbuscular mycorrhizal fungi. Oecologia. 138: 574-583.

Pirngadi, K. 2009. The Constribution of Organic Matter on Inreasing Rice Yield to support Sustainable Agriculture and National Food Security. Journal of Agricultural Innovation Development. 2(1):48-64.

Prakhas, Y.S., Bhadoria, P.B.S. and Rakshit, A. 2002. Relative efficacy of organic manure in improving milling and cooking quality of rice. IRRN. 27(1):43 – 44.

Rasmussen, P.E. and Parton, W.J. 1994. Long-term effects of residue management in wheat-fallow: I. Inputs, yields, and soil organic matter. Soil Science Society of America Journal. 58:523-530.

Ray, S.S. and Gupta, R.P. 2001. Effect of green manuring and tillage practices on physical properties of puddled loam soil under rice-wheat cropping system. Journal of Indian Society Soil Science. 49(4):670 – 678.

Reganold, J.P., Elliott, L.F. and Unger, Y.L. 1987. Long-term effects of organic and conventional farming on soil erosion. Nature 330: 370-372.

Sharma, K.L., Kusuma Grace J. Mandal, U.K., Gajbhiye, P.N., Srinivas, K., Korwar, G.R., Bindu, V.H., Ramesh, V., Ramachandran, K. and Yadav, S.K. 2008. Evaluation of long-term soil management practices using key indicators and soil quality indices in a semi-arid tropical Alfisol. Australian Journal of Soil Research. 46: 368 – 377

Soil Research Institute. 2009. Penuntun analisa kimia tanah, tanaman, air dan pupuk (Procedure to measure soil chemical, plant, water and fertilizer). Soil Research Institute, Bogor. 234 p. (in Indonesian).

Sommerfeldt, T.G., Chang, C. and Entz, T. 1988. Long-term annual manure applications increase soil organic matter and nitrogen, and decrease carbon to nitrogen ratio. Soil Science Society of America Journal. 52:1668-1672.

Stolze, M., Piorr, A., Harring, A. and Dabbert, S. 2002. The environmental impact of organic farming in Europe. Organic farming in Europe: Economics and Policy. Vol 6. University of Hohenheim, Germany.

Sukristiyonubwo and Damasus Riyanto. 2019. Paper was submitted to Indonesian Soil and Climate Journal and being reviewd. 21 p

Sukristiyonubowo, Damasus Riyanyo and Sugeng Widodo.2018a. Move to organic farming: Chemical and physical soil properties of organic and conventional vegetables reasons. Paper presented at International Seminar Series: Horticulture for the quality life, held in IPB International Convention Center Bogor, December 10th.12 p

Sukristiyonubowo, Rahmat, A.P. and Damasus Riyanto. 2018b. Soil chemical and physical characteristic and rice yields under three farming systems in Sragen District, Central Java Province. Indonesian Soil and Climate Journal. Vol 39 (1): 19 - 24

Sukristiyonubowo, Benito, H.P. and Edi Husen. 2015. Soil properties under organic and conventional vegetables farming system in Bogor District. Indonesian Soil and Climate Journal. Vol 42 (1): 53 - 56

Sukristiyonubowo, Wiwik, H., Sofyan, A., Benito, H.P. and De Neve S. 2011. Change from conventional to organic rice farming: Biophysical and Socioeconomic Reasons.Journal of Sgricultural Science and Soil Science. 3(5):172-182.

USDA. 1999. Soil quality indicators: Physical, chemical and biological indicators for soil quality assessment and management. 2p

Wander, M.M., Traina, S.J., Stinner, B.R. and Peters, S.E. 1994. Organic and conventional management effects on biologically active organic matter pools. Soil Science Society of America Journal. 58: 1130-1139

Whitbread, Anthony, M., Blair Graeme J. and Lefroy, R.D.B. 2000. Managing legume leys, residues and fertilisers to enhance the sustainability of wheat cropping system in Australia. 1. The effects on wheat yields and nutrient balance. Soil and Tillage Research. 54: 63 – 75

Yan, D, Wang D. and L, Yang. 2007. Long term effect chemical fertiliser, straw and manure on labile organic matter in a paddy soil. Biol. Fertil. Soil Journal. 44:93-101