The Use of Water Hyacinth (Eichhorniacrassipes) Bokashi by Single and Multiple Cropping Systems of the Soybean, Corn, and Dry Land Rice

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Abstract: The use of water hyacinth (Eichhorniacrassipes) bokashi by single and multiple cropping systems of the soybean, corn, and dry land rice. This study is aimed to find out the effect use of water hyacinth bokashion growth and production of soy bean, corn, and dry land rice by single and multiple cropping systems and farm income. The study was conducted at Sengkang, South Sulawesi, Indonesian. The experiment using randomized complete block design with based on two factor design. The first factor that of no water hyacinth bokashi, 1 ha’ water hyacinth bokashi, 2 th’ water hyacinth bokashi and by single and multiple cropping systems of soybean, corn, and dry land rice as the second factor. The results of experiment indicated that the application 2 t h’ water hyacinth bokashi, the provided better effect toward growth and production of soybean, corn, and dry land rice, and than multiple cropping systems of soybean-corn-dry land rice, at the provided higher production and farm income with different single cropping system. The interaction between of the 2 t h’ water hyacinth bokashi and multiple cropping systems by of soybean-corn-dry land rice, and provided better yields on production and farm income. Suggestion is application of water hyacinth bokashi above 2 ha’ needs to be tested by the use of a cropping system.

Keywords: Water hyacinth bokashi, cropping systems, soybean, corn, and dry land rice

1. Introduction

Agriculture is facing many problems and challenges in this century, such as the decrease in farming areas, soil erosion, water resources reduced, global warming, and population growth. Estimate’s FAO of that agricultural productivity must double by 2025 to meet the increasing demand for food due to population increase, and to overcome the decline in agricultural resources. So the biggest challenge for agriculture is how to produce more food with higher efficiency, but with minimal environmental impact. The solution is to crop rotation activity (Zeng Xi-Bai et al., 2007), intercropping plants, or composting or bokashi (Fumiai TAKAKAI et al., 2010 and Zirbes L., Q. Renard, Dufey J. et al., 2011).

Indonesian population growth is still high, at around 1.37 percent each year, so that when in 2013 the population of Indonesians much as approximately 248.8 million people every year it will be increased by about 3.41 million people. This means, the need for agricultural products, especially food stuffs such as rice, corn, and soybeans grew greater (BPS - Statistics Indonesia, 2014).

On the other hand, the production of rice, corn, and soybeans are still fluctuating. Various efforts have been undertaken to continuously improve food production through extension and intensification. Extending the opportunities wane, because the intensification need to be increased. During the implementation of the intensification of the cropping system single show increased productivity are getting smaller, the price of the means of production is high, more use of organic fertilizer and less use of organic materials, the selling price is low, the risk of farming is high, farm income is low, the welfare of farmers is not improving and land capability decreases.

Improve of soil fertility by providing of organic fertilizer of alone is not enough, the addition of organic matter such as green manure, manure, and crop residues or compost is needed. One untapped aquatic plants, especially in South Sulawesi is water hyacinth being very disturbing society, particularly those in areas such as coastal waters of Tempe Lake, Wajo Regency, South Sulawesi for obstructing traffic back and forth to the waters of Tempe Lake. Therefore it is necessary to do research on the utilization of water hyacinth in the agricultural business by using it as raw material Bokashi.

According to Fryer and Matsunaka in Remosova (1999), water hyacinth is a material with huge potential to be used as organic fertilizer because it is based on the results of laboratory analysis contains among others: 1.681% N, 0.275% P, 14.286% K, 37.654% C, with the ratio C / N 22.399. Water hyacinth can be used as compost on a large scale (John E. Montoya, et al., 2013), to produce bioethanol (Toshibuki Takagi, et al., 2012), and can be used as fodder (Wenbiao Wu, et al., 2014).

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Based on the above, it is necessary to develop a better system that is capable of increasing the utilization of natural resources, is able to increase the productivity of land, able to increase farm income, and is able to maintain the ability of the land, so as to improve the welfare of the farmer and his family.

The purpose of research there are three: first is to study the effect of the use of some of dose water hyacinth Bokashi on the growth and yield of soybean, corn and dry land rice. The second is studying the use of a single crop and intercropping system of soybean-corn- dry land rice to production and farm income. And the third is to study the interaction between the use water hyacinth Bokashi and cropping systems of soybean-corn-dry land rice to production and farm income.

2. Materials and Methods

2.1 Analysis Methods

This study is based on a randomized block design (RBD) with factorial pattern of two factors. The first factor is the water hyacinth Bokashi dose (B), which consists of three levels ie without water hyacinth Bokashi (b0), 1 t h⁻¹ water hyacinth Bokashi (b1), 2 t h⁻¹ water hyacinth Bokashi (b2). The second factor is the Planting System(T) soybean, corn and dry land rice which consists of kinds seven of soybean single(t1), corn single(t2), dry land rice single(t3), the combination of soybean-corn(t4), the combination of soybean-dry land rice(t5), the combination of corn-dry land rice(t6), and the combination of soybean-corn-dry land rice(t7).

2.2 Data Analysis

Data analysis is the effect on the water hyacinth bokashi; cropping system; interaction between water hyacinth bokashi and cropping systems; the value of production; the productivity of plant and land; and analysis of farmland income

3. Results and Discussion

3.1 Water HyacinthBokashi

Soybean. The HSDα of 0.05 indicates that application of water hyacinth Bokashi₂ t h⁻¹ gives better effect than with water hyacinth Bokashi₁ t h⁻¹ and without water hyacinth Bokashi. While water hyacinth bokashi₁ t h⁻¹ is better than without Bokashi. Based on the results of statistical analysis that application of water hyacinth Bokashi does not give real effect to a number of generative growth parameters of plants except the number of pods per hill and the percentage of empty pods, but significantly affected the vegetative growth of soybean plants.

The influence water hyacinth Bokashi real against the vegetative growth of plants suspected, that at the beginning of plant growth nutrient content of water hyacinth Bokashi(Boqi Weng, et al., 2012), still be able to supply the needs (Wenbiao Wu, et al., 2014; Md. M. R. Khan, et al., 2014) of the soybean plants, yet ahead of the generative phase, nutrient availability has begun to diminish until finally not be inadequate, so the impact on development of the generative phase relatively stunted plants. Another factor that is thought to affect change in climate conditions have a negative impact that the prolonged drought that is very limited availability of water for plant growth.

Bokashiaplication of water hyacinth can increase soil organic matter content, then physically, chemistry, and biology can improve soil quality. According Syam’un in Nirvana (2002), that the addition of compost (John E. Montoya, et al., 2013; Jiwan Singh and Ajay S. Kalamdhad, 2013) can improve soil organic matter content. High organic matter content can increase crop production. According to Nirvana (2002), that the provision of compost 10 t h⁻¹ can improve growth and increase the production of soybeans (F. Takakai et al., 2010).

Corn, The HSDα of 0.05 indicates that application of water hyacinth Bokashi₂ t h⁻¹ gives better effect than with water hyacinth Bokashi₁ t h⁻¹ and without water hyacinth Bokashi, and than water hyacinthBokashi₁ t h⁻¹ is better than without bokashi. Based on the results of statistical analysis that application of water hyacinth Bokashi not significant effect on the amount of corn cob, while all parameters of generative growth of plants showed significant effect on the growth and yield of corn.

Dry land rice, The HSDα of 0.05 indicates that application of water hyacinth Bokashi₂ t h⁻¹(Zirbes L., Renard Q., Dufey J. et al., 2011) gives a better effect than with water hyacinth Bokashi₁ t h⁻¹ and without water hyacinth Bokashi, and than water hyacinthBokashi₁ t h⁻¹ is better than without bokashion dry land rice crop.

3.2 Cropping Systems

Soybean, Analysis of variance showed that intercropping between soybean and corn are the best, although a single crop of soybean is still high compared with inter cropping, but based on test results of 0.05α HSD no real difference(ZENG Xi-bai et al. 2007) between the single cropping system with intercropping of soybean cropping system of corn(Supriyono, 2014).This is due to the lack of competition between soybean with corn, so as to maximize growth to yield almost the same with a single crop.

Dry land rice, The HSD α of 0.05 indicates that overall both vegetative and generative parameter turns cropping system intercropped dry land rice-corn is the best. This is due to the lack of competition between plants, so it can utilize nutrients and sunlight to maximize growth, which in turn can generate maximum production(ZENG Xi-bai et al. 2007).
4. Interaction between of water hyacinth and cropping systems

Soybean. Results of the study of interaction between of water hyacinth Bokashi and cropping systems no significant effect on all parameters, but all the measured parameters of generative parameter primarily, interaction between of water hyacinth Bokashi2 t/ha and cropping system is highest (ZENG Xi-bai et al. 2007). Corn, Results of the study of interaction between of water hyacinth Bokashi and cropping systems no significant effect on all parameters, but all the measured parameters of generative parameter primarily, interaction between of water hyacinth Bokashi2 t/ha and cropping system single is highest (ZENG Xi-bai et al. 2007).

And dry land rice, The HSD0.05 show that the interaction between of water hyacinth Bokashi2 t/ha and intercropping system of rice and corn are the best, especially in generative parameters the production obtained (ZENG Xi-bai et al. 2007).

5. Value of Production

The HSD0 of 0.05 showed of significant differences as well as the highest and best obtained on the use of water hyacinth Bokashi2 t/ha and intercropping of soybean, corn and dry land rice, good of yield value of perrumpun, the yield value of per plot, as well as the yield value of per hectare. This is due to a combination of the three commodities, so that the value of their products so high. According Muginsjah and Setiawan (1990), double cropping can produce a total production (F. Takakai et al., 2010) of plants was greater than the production of crop each, although the production of one or all plants is lower than the production of single plant each.

6. Productivity

**Plant Productivity.** The analysis showed that the decrease in the production of soybeans, corn, and dry land rice if the intercropped between the two in combination with other plants or more, compared to the production of single plant each (Table 1). The average production is lower 0.32 to 0.37 percent for soybeans, from 4,34 to 12.11 percent for corn, from 14.87 to 54.43 percent for dry land rice, and 12.11 to 54.43 percent for the combination of all three, except found in a combination of corn-soybean, corn-dry land rice, and their combination for without bokashi, which resulted in the production of corn 37.77; 49.40; 65.92 percent, and thana combination of corn-soybeans and their combination for water hyacinth Bokashi1 ha which resulted 11.94 percent and 17.40 percent. The cause of the increase was due to the suppression of pest’s diseases and weeds. Migginsjah and Setiawan (1990), that causes increased production of corn intercropped with peanuts because of depressed corn stalk borer attack and growth of weeds (Emily J. Wundrow, 2010; Tolul Olufunmilayo Ajayi and Atoke Olaiye Ogundaya, 2012; Toshiyuki Takagi, et al., 2012; dan ZENG Xi-bai et al. 2007) which result in the increased weight of dry beans per plant corn.

Land Productivity. The results showed that the rate of land productivity as measured by the ratio of the land of equality.

"LER (Land Equivalent Ratio), shows that all inter cropped plants, both intercropping two plants and three plants intercropped an increase inland productivity. Intercropping of soybean-dry land rice (Supriyono, 2014) as the best intercropping (LER 2.719), and intercropping of soybeans-dry land rice as the ugliest (LER 1.340), which can be seen in Table 2. The cause of the increase inland productivity due to precise determination of the cropping system used. According Muginsjah and Setiawan (1990), an increase inland productivity due to the selection of a combination of plants and proper cropping systems (ZENG Xi-bai et al. 2007).

7. Analysis of Revenue

Results of the analysis of R/Cand B/C ratio (Table 3) shows that the farm use of Bokashi and single cropping systems, intercropping of soybeans, corn, dry land rice is very profitable and feasible tobe developed by farmers because it has a value of R>C1 and B/C>1, Dwi Rachiminad Maryono, (2008). R.A. Umi Kalsum, (2013), the conclusions drawn from the analysis of R/Cand B/C equally if R/C or B/C>1 Profitable, if R/C and B/C<1 is not Profitable(loss), and if R/C or B/C =1 no profit and no loss(break-even).

### Table 1: The average production of grain or dry grain per hectare in use of Bokashi and single cropping systems and intercropping of soybeans, corn, dry land rice in ha.

<table>
<thead>
<tr>
<th>Bokashi</th>
<th>Soybean</th>
<th>Corn</th>
<th>Dryland rice</th>
<th>Soybean Dryland rice</th>
<th>Soybean Corn Dryland rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>b0</td>
<td>1.05</td>
<td>1.72</td>
<td>1.25</td>
<td>0.00</td>
<td>(0.00)</td>
</tr>
<tr>
<td>b1</td>
<td>1.65</td>
<td>2.12</td>
<td>1.25</td>
<td>0.00</td>
<td>(0.00)</td>
</tr>
</tbody>
</table>

### Table 2. Mean of Land Equivalent Ratio on the use of Bokashi and single cropping systems and intercropping of soybeans, corn, dry land rice in ha.

<table>
<thead>
<tr>
<th>Bokashi</th>
<th>Soybean</th>
<th>Corn</th>
<th>Dryland rice</th>
<th>Soybean Dryland rice</th>
<th>Soybean Corn Dryland rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>b0</td>
<td>1.00</td>
<td>2.27</td>
<td>1.30</td>
<td>1.48</td>
<td>-</td>
</tr>
<tr>
<td>b1</td>
<td>1.00</td>
<td>2.11</td>
<td>1.72</td>
<td>1.43</td>
<td>-</td>
</tr>
<tr>
<td>b2</td>
<td>1.00</td>
<td>1.82</td>
<td>1.34</td>
<td>2.02</td>
<td>-</td>
</tr>
</tbody>
</table>

**Description:** The data of underlined for single planting, while those in parentheses are the difference average percent in production due to intercropping.

**Description:** The data of underlined for single planting, while those in parentheses are the difference average percent in production due to intercropping.
8. Conclusion

Application of water hyacinth Bokashi2 t ha⁻¹, gives the best effect on the growth and production of soybean, corn, and dry land rice; The use of inter cropping systemsof soybean-corn-dry land rice, gives of production and good farm incomeof compared with singly cropping systems; and Interaction between water hyacinth Bokashi2 t ha⁻¹ and inter cropping systemsofsoybean-corn-dry land rice, is the best on the production and farm income.

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