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

Asrijal[1], Yunus Musa[2], Ambo Upe[3], Bachrul Ibrahim[4], Rahmawati[5]

[1]School of Agriculture Sciences, Puangrimaggalatung, Sengkang, South Sulawesi, 90915, Indonesia

[2]Department of Agriculture Cultivation, Faculty of Agriculture, Hasanuddin University, Makassar, South Sulawesi, 90245, Indonesia

[3]School of Agriculture Sciences, Puangrimaggalatung, Sengkang, South Sulawesi, 90915, Indonesia

[4]Department of Soil Sciences, Faculty of Agriculture, Hasanuddin University, Makassar, South Sulawesi, 90245, Indonesia

[5]School of Agriculture Sciences, Puangrimaggalatung, Sengkang, South Sulawesi, 90915, Indonesia

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 tha^{-1} water hyacinth bokashi, 2 th^{-1} 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^{-1} 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^{-1} 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 applicationof water hyacinth bokashiabove2tha^{-1}needs to be testedbythe use ofcropping 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. Eestimate'sFAO 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 (Fumiaki TAKAKAI, et al., 2010 and Zirbes L., Q. Renard, Dufey J. et al., 2011).

Indonesian population growth is still high, at around1.37percent each year, so that when in 2013the population of Indonesianas much asapproximately248.8 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 handthe 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 (Toshiyuki Takagi, et al., 2012), and can be used as fodder (Wenbiao Wu, et al., 2014) , 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 secondis 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 factoris the water hyacinth Bokashi dose (B), which consists of three levels ie without water hyacinth Bokashi(b_0), 1 t h^{-1}water hyacinth Bokashi(b_1), 2 t h^{-1}water hyacinth Bokashi(b_2). The second factor is the Planting System(T) soybean, cornand dry land rice which consists of kinds seven of soybean single(t_1), corn single(t_2), dry land rice single(t_3), the combination of soybean-corn(t_4), the combination of soybean-dry land rice(t_5), the combination of corn-dry land rice(t_6), and the combination of soybean-corn-dry land rice(t_7).

2.2 Data Analysis

Data analysis is the effect on thewater hyacinth bokashi; cropping system; interaction betweenwater hyacinth bokashi and cropping systems; the value of production; the productivity ofplant and land; andanalysis offarmincome

3. Results and Discussion

3.1 Water HyacinthBokashi

Soybean. The HSDα of 0.05 indicates that application of water hyacinth Bokashi2 t h^{-1}givesa 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 el., 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 HSDαof 0.05indicatesthat application ofwater hyacinth Bokashi2 t h^{-1}givesa better effect than withwater hyacinth Bokashi1t h^{-1} and without water hyacinth Bokashi, and thanwater hyacinthBokashi1t $h^{-1}$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 corncob, while all parameters of generative growth of plants showed significant effect on the growth and yield of corn.

Dry land rice,The HSDα of 0.05indicatesthat aplication ofwater hyacinth Bokashi2 t h^{-1}(Zirbes L., Renard Q., Dufey J. et al.. 2011) gives a better effect than with water hyacinth Bokashi1t h^{-1}andwithout water hyacinth Bokashi, and than water hyacinthBokashi1th^{-1}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 0.05αHSD 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.

Corn, Analysis of variance showed that intercropping between corn-dry land rice-soybean is the best, because from 0.05α HSD test results showed significantly different results with other cropping systems. This is because corn plants have a relatively faster growth (Supriyono, 2014) compared with other crops, so as to take advantage of sunlight (ZENG Xi-bai *et al.* 2007) for photosynthesisto the fullest.

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 hyacinths bokashi andcropping 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 betweenof water hyacinth Bokashi2 t h^{-1}andsingle 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 $h^{-1}$and cropping system single is highest(ZENG Xi-bai *et al.* 2007). And Dry land rice, The HSDα0:05showsthat the interaction between of water hyacinth Bokashi2 t $h^{-1}$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 HSDα of 0.05 showed of significant differences as well as the highest and best obtained on the use of water hyacinthBokashi2 t $h^{-1}$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 Mugnisjah 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 ofsingle plant each (**Table 1**). The average production is lower 0, 32to31,27percentfor soybeans, from 4, 34 to 12,11percentforcorn, from 14,87 to 54,43percentfordry 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 corn37,77; 49,40; 68, 92 percent, and thana combination of corn-soybeans and their combination for water hyacinth Bokashi1t h^{-1}which resulted11,94percentand17,40percent. The cause of the increase was due to the suppression of pest's diseases and weeds. Mugnisjah and Setiawan(1990), that causes increased production of corninter cropped with peanuts because of depressed corn stalk borer attack and growth of weeds (Emily J. Wundrow, 2010; Tolu Olufunmilayo Ajayi and Atoke Olaide Ogunbayo, 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 EquivalentRatio), shows that all inter cropped plants, both intercropping two plants and three plants intercropped an increase inland productivity. Intercropping of soybean-corn-dry land rice (Supriyono, 2014) as the best intercropping (LER 2,719), and intercropping of soybean-cropping 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 Mugnisjah 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/C>1andB/C>1,Dwi Rachminadan Maryono, (2008).R.A. Umi Kalsum, (2013), the conclusions drawnfrom the analysis of R/CandB/C equally if R/Cor B/C>1Profitable, if R/CorB/C<1 is notProfitable(loss), and ifR/CorB/C=1no 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 soybean, corn, dry land rice (t h^{-1})

Bokashi	Crops Combination	Production of grain or dry grain (t h^{-1})			
		Soybean	Corn	Dry land rice	Combination
b_0	Soybean	1,906 (0,00)	1,729 (+37,77)	1,88 (-40,51)	1,405 (-26,29)
	Corn	1,713 (-10,13)	1,255 (0,00)	2,69 (-14,87)	1,875 (+49,40)
	Dry land rice	1,625 (-14,74)	2,120 (+68,92)	3,16 (0,00)	1,54 (-51,27)
	Combination	1,405 (-26,29)	1,875 (+49,40)	1,54 (-51,27)	0,00 (0,00)
b_1	Soybean	1,881 (0,00)	2,682 (+11,94)	2,08 (-51,74)	1,390 (-26,10)
	Corn	1,875 (-0,32)	2,396 (0,00)	3,31 (-23,20)	2,813 (+17,40)
	Dry land rice	1,750 (-6,96)	2,292 (-4,34)	4,31 (0,00)	2,26 (-47,56)
	Combination	1,390 (-26,10)	2,813 (+17,40)	2,26 (-47,56)	0,00 (0,00)
b_1	Soybean	2,056 (0,00)	3,307 (-6,21)	2,40 (-50,52)	1,413 (-31,27)
	Corn	1,815 (-11,72)	3,526 (0,00)	3,55 (-26,80)	3,099 (-12,11)
	Dry land rice	1,738 (-15,47)	3,271 (-7,23)	4,85 (0,00)	2,21 (-54,43)
	Combination	1,413 (-31,27)	3,099 (-12,11)	2,21 (-54,43)	0,00 (0,00)

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

Table 2. Means of Land Equivalent Ratio on the use of Bokashi and single cropping systems and intercropping of soybean, corn, dry land rice (t h^{-1})

Bokashi	Crops Combination	Production of grain or dry grain (t h^{-1})			
		Soybean	Corn	Dry land rice	Combination
b_0	Soybean	1,00	2,276	1,448	-
	Corn	2,276	1,00	2,54	-
	Dry land rice	1,448	2,54	1,00	-
	Combination	-	-	-	2,719
b_1	Soybean	1,00	2,116	1,413	-
	Corn	2,116	1,00	1,725	-
	Dry land rice	1,413	1,725	1,00	-
	Combination	-	-	-	2,437
b_2	Soybean	1,00	1,821	1,340	-
	Corn	1,821	1,00	1,660	-
	Dry land rice	1,340	1,660	1,00	-
	Combination	-	-	-	2,022

Description: The data of underlined words for a single planting

Table 3.
Analysis of revenue per hectare on the use of Bokashi and single cropping systems and intercropping of soybean, corn, dry land rice (Rp. 000)

Treatment		Receipts	Expenses	Income	R/C - ratio	B/C - ratio
b_0	t_1	6.672,00	1.017,00	5.655,00	6,56	5,56
	t_2	1.977,70	974,00	1.003,70	2,03	1,03
	t_3	3.791,69	930,00	2.861,69	4,08	3,08
	t_4	7.953,37	1.299,00	6.654,37	6,12	5,12
	t_5	7.945,26	1.307,00	6.638,26	6,08	5,08
	t_6	5.859,03	1.264,00	4.595,03	4,64	3,64
	t_7	9.212,40	1.389,00	7.823,40	6,63	5,63
b_1	t_1	6.584,33	1.393,00	5.191,33	4,73	3,73
	t_2	3.891,27	1.350,00	2.541,27	2,88	1,88
	t_3	5.172,16	1.306,00	3.866,16	3,96	2,96
	t_4	10.183,50	1.675,00	8.508,50	6,08	5,08
	t_5	8.622,87	1.683,00	6.939,87	5,12	4,12
	t_6	7.240,04	1.640,00	5.600,04	4,41	3,41
	t_7	11.644,36	1.765,00	9.879,36	6,60	5,60
b_2	t_1	7.197,33	1.689,00	5.508,33	4,26	3,26
	t_2	5.522,93	1.646,00	3.876,93	3,36	2,36
	t_3	5.816,37	1.602,00	4.214,37	3,63	2,63
	t_4	10.315,60	1.971,00	8.344,60	5,23	4,23
	t_5	8.960,58	1.979,00	6.981,58	4,53	3,53
	t_6	8.642,16	1.936,00	6.706,16	4,46	3,46
	t_7	11.675,14	2.061,00	9.614,14	5,66	4,66

8. Conclusion

Application of water hyacinth Bokashi2 t h^{-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 $h^{-1}$and inter cropping systemsofsoybean-corn-dry land rice, is the best on the production and farm income.

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References

[1] Boqi Weng, Junli Zhou, Siping Zheng, Xiuxia Chen, Weiguang Zhang, and Qin Huang, 2012. Field Utilization of Dried Water Hyacinth for Phosphorous Recovery from Source-Separated Human Urine. *Journal of Environmental Protection*, 2012, 3, 715-721 doi:10.4236/jep.2012.38085 Published Online August 2012 (http://www.SciRP.org/journal/jep).

[2] BPS - Statistics Indonesia, 2014. Indonesian Statistical(*Statistical Yearbook of Indonesian, 2014*). Publication Number:07330.1406. BPS Catalog:1101001. Number of Pages:xxxviii+634pages. ISSN:0126-2912. www.bps.go.id.

[3] DwiRachminadanMaryono, 2008. Technical Efficiency and Income Analysis for Certified Rice Seed Program: Stochastic Production Frontier Aproach. JurnalAgribisnisdanEkonomiPertanian (Volume 2. No 2 – Desember 2008). DepartemenAgribisnis, FakultasEkonomidanManajemen IPB.

[4] Emily J. Wundrow, Juli Carrillo, Christopher A. Gabler, Katherine C. Horn, Evan Siemann, 2010. Facilitation and Competition among Invasive Plants: A Field Experiment with Alligatorweed and Water Hyacinth. PLOS ONE | www.plosone.org. October 2012 | Volume 7 | Issue 10 | e48444. PLoS ONE 7(10): e48444. doi:10.1371/journal.pone.0048444.

[5] Fumiaki TAKAKAI; Masato TAKEDA; Kazuhiro KON; Kazuhiro INOUE; Shinpei NAKAGAWA; Keiji SASAKI; Atsushi CHIDA; Kazuki SEKIGUCHI; Toshinori TAKAHASHI; Takashi SATO; and Yoshihiro KANETA, 2010. Effects of preceding compost application on the nitrogen budget in an upland soybean field converted from a rice paddy field on gray lowland soil in Akita, Japan. Journal Soil Science and Plant Nutrition. 56, 760–772. doi: 10.1111/j.1747-0765.2010.00503.x

[6] International Rice Research Institute, 1974. Annual Report for 1973.

[7] Jiwan Singh and Ajay S. Kalamdhad, 2013. Reduction of bioavailability and leachability of heavy metals during vermicomposting of water hyacinth. RESEARCH ARTICLE. Environ Sci Pollut Res (2013) 20:8974–8985. DOI 10.1007/s11356-013-1848-x.

[8] John E. Montoya, Tina M. Waliczek, and Michael L. Abbott, 2013. Large Scale Composting as a Means of Managing Water Hyacinth (Eichhornia crassipes). Invasive Plant Science and Management 2013 6:243–249. DOI: 10.1614/IPSM-D-12-00013.1.

[9] John E. Montoya, Tina M. Waliczek, and Michael L. Abbott, 2013. Large Scale Composting as a Means of Managing Water Hyacinth (*Eichhorniacrassipes*). Invasive Plant Science and Management 2013 6:243–249. DOI: 10.1614/IPSM-D-12-00013.1

[10] Lara Zirbes, Quentin Renard, Joseph Dufey, Pham Khanh Tu, Hoang Nghia Duyet, Philippe Lebailly, Frédéric Francis, Eric Haubruge, 2011. Valorisation of a water hyacinth in vermicomposting using an epigeic earthworm *Perionyx excavatus* in Central Vietnam. *Biotechnol. Agron. Soc. Environ.* 2011, 15(1), 85-93.

[11] Lara Zirbes; Quentin Renard; Joseph Dufey; Pham KhanhTu; Hoang NghiaDuyet; Philippe Lebailly; Frédéric Francis; and Eric Haubruge, 2011. Valorisation of a water hyacinth in vermicomposting using an epigeic earthworm *Perionyxexcavatus*in Central Vietnam. Journal *Biotechnol. Agron. Soc. Environ.* 15 (1), 85 – 93.

[12] Md. M. R. Khan, M. Z. B. Mukhlish, M. S. I. Mazumder, K. Ferdous, D. M. R. Prasad, and Z. Hassan, 2014. Uptake of Indosol Dark-blue GL dye from aqueous solution by water hyacinth roots powder: adsorption and desorption study. ORIGINAL PAPER. Int. J. Environ. Sci. Technol. (2014) 11:1027–1034. DOI 10.1007/s13762-013-0363-4.

[13] Mugnisjah, W.G.andSetiawan, A., 1990.Introductionof Seed Production. PT. RajaGrafindoPersada, Jakarta, (*in Indonesia*).

[14] Nirwana, 2002.Improving the Effectivenessof methanoltodrive upof Soybean Productionby CompostAdding (*Thesis*). Graduate Program, University of MakassarHasanuddin, Makassar, (*in Indonesia*).

[15] R.A.UmiKalsum, 2013. An analysis of revenue and economic viability of rice farming in the Agropolitan Regional of Gandus Village, Pulokerto District,

Palembang. Scientific Journal AgrIBA 1 Edition March 2013. ISSN: 2303-1158,, (*in Indonesia*)

[16] Remosova 1999., *The Impacts of Organic manure on Weed Infestation*., http : // www. Mendelu . CZ / Veda / disertace / af / remesova. html (Online)

[17] Supriyono, 2014. Applicationssustainable agriculturethroughintercroppingmaizebeans.LPPMUNS, Research, BOPTNUNS, *GrantProfessor*, 2012.http://eprints.uns.ac.id/id/eprint/13410

[18] Sys C.E.V., Ranst, and J.Debaveye, 1991. Land Evaluation. General Administration for Development Cooperation Place du Champ dengan Mars 5 bte 57 – 1050 Brussels-Belgium.

[19] Tolu Olufunmilayo Ajayi and Atoke Olaide Ogunbayo, 2012. Achieving Environmental Sustainability in Wastewater Treatment by Phytoremediation with Water Hyacinth (*Eichhornia Crassipes*), (2012). Journal of Sustainable Development; Vol. 5, No. 7; 2012, ISSN 1913-9063 E-ISSN 1913-9071. Published by Canadian Center of Science and Education. doi:10.5539/jsd.v5n7p80. URL: http://dx.doi.org/10.5539/jsd.v5n7p80.

[20] Toshiyuki Takagi, Motoharu Uchida, Ryoji Matsushima, Masami Ishida, and Naoto Urano, 2012. Efficient bioethanol production from water hyacinth Eichhornia crassipes by both preparation of the saccharified solution and selection of fermenting yeasts. Fish Sci (2012) 78: 905–910. ORIGINAL ARTICLE Chemistry and Biochemistry. DOI 10.1007/s12562-012-0516-2

[21] Toshiyuki Takagi, Motoharu Uchida, Ryoji Matsushima, Masami Ishida, and Naoto Urano, (2012). Efficient bioethanol production from water hyacinth Eichhorniacrassipes by both preparation of the saccharified solution and selection of fermenting yeasts. Fish Sci2012 78:905–910. DOI 10.1007/s12562-012-0516-2.Chemistry and Biochemistry. The Japanese Society of Fisheries Science 2012.

[22] Wenbiao Wu, XiaoguangGuo and Mingliang Huang, 2014. Evaluation of acute toxicity potential of water hyacinth leaves. Toxicology and Industrial Health 2014, Vol. 30(5) 426–431 © The Author (s) 2012. Reprints and permissions: sagepub.co.uk/ journals Permissions.nav DOI: 10.1177/0748233712458138. tih.sagepub.com.

[23] Wenbiao Wu, Xiaoguang Guo, and Mingliang Huang, 2014. Evaluation of acute toxicity potential of water hyacinth leaves. Article, Toxicology and Industrial Health. 2014, Vol. 30(5) 426–431. sagepub.co.uk/ journals Permissions.nav. DOI: 10.1177/0748233712458138. tih.sagepub.com.

[24] ZENG Xi-bai; SUN Nan; GAO Ju-sheng; WANG Bo-ren; and LI Lian-fang, 2007. Effects of Cropping System Change for Paddy Field with Double Harvest Rice on the Crops Growth and Soil Nutrient. ScienceDirect. Journal Agricultural Sciences in China. 6 (9): 1115-1123.