Biological ash from bottom coal ash mixed with beneficial fungi on the growth of rice var Pathumthani 1

Suphawat Kowapradit[1], Wattanachai Pongnak[1] and Kasem Soytong[2*]

[1]Department of Soil Science, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand
[2]Department of Plant Pest Management, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand

Kowapradit, S., Pongnak, W. and Soytong, K. (2007). Biological ash from bottom coal ash mixed with beneficial fungi on the growth of rice var pathumthani 1. Journal of Agricultural Technology 3(1): 129-136.

It is clearly showed that the biological ash mixed to 7 species of fungi have produced amylase, cellulose, protease and ligninase as follows:- *Aspergillus sparsus, Chaetomium lucknowense, Achaetomium theilaviopsis, Paecilomyces marquandii, Emericella nidulans, Eurotium herbariorum* and *Arthrobotrys oligospora*, and the other 4 species produced amylase, cellulose and ligninase as follows:- *Trichoderma hamatum, T. hamatum* (T-12), *Mucor hiemalis* and *M. circinelloides* increased in plant height, number of tillers, number of grains per panicle, number of panicle per tiller and grain weight per panicle. It was also indicated that the bio-ash has affected to higher soil fertility which increased in plant nutrients available for the growth of rice var Prathumthani 1. The bio-ash treatments of 25, 50 and 75 kg/rai were not significantly differ in yield and increased the yield as 52.38, 49.05 and 56.59 %, respectively and it was significantly higher when compared to the non-treated one. This may due to the activities of beneficial fungi added into the bottom ash. It is suggested that the biological ash may possible to develop to be used to increase yield and reduce the chemical use.

Keywords: biological ash, bottom ash

Introduction

Bottom Ash is the residue from coal which sedimentary from plant debris under soil for million years. The coal has been used for heating the industrial factory such as electrical factory for giving heat energy by burning at high temperature ca. 1,100-1,400 C, since then the remaining residue called coal ash. The heating was affected to various oxides and some part of 15-25 % coal ash was melted and mixed to be a big one and fall into the burning room called bottom ash or furnace ash. Kowapradit (2005) reported that the bottom ash may contain some essential elements for plant growth like potassium, calcium

[*]Corresponding author: Kasem Soytong; e-mail: kskasem@kmitl.ac.th

and magnesium etc which would be the form of available to plant absorption for their growth. Imiurb (1992) stated that the paddy soil has reported to decreased in organic matter leading to low soil fertility, acidity which become less response to chemical fertilizer application. It is important that adding soil conditioners will lead to balance soil to be neutral and possible increase in yield. While, Cheanrung *et al.* (2006) reported that soil conditioner are normally substances from the natural resources or the synthesizes substances which used to improve the physical and chemical soil properties to favor for plant growth but the soil amendment is the substances which contain more plant nutrient. However, there are many researchers have been used rice straw to manage yield and nitrogen utilization for rice growth as organic amendments (Eagle *et al.*, 2000; Kumar and Goh, 2000; Bird *et al.*, 2001; Eagle *et al.*, 2001). However, the bottom ash has become interesting to be used as an addition soil conditioner which high potassium, phosphorus and calcium which may possible useful for plant growth (Kowapradit, 2005).

The objectives of project were studied on the properties of bottom ash from electricity factory applying in paddy rice soil and testing the biological ash which developed from bottom ash by adding the beneficial fungi for growing rice var Prathumthani 1.

Materials and methods

Formulation of biological ash

The biological of bottom ash has developed by mixing the screened beneficial fungi offered by Dr. Kasem Soytong which 7 species of fungi have produced amylase, cellulose, protease and ligninase as follows:- *Aspergillus sparsus, Chaetomium lucknowense, Achaetomium theilaviopsis, Paecilomyces marquandii, Emericella nidulans, Eurotium herbariorum* and *Arthrobotrys oligospora,* and the other 4 species produced amylase, cellulose and ligninase as follows; *Trichoderma hamatum, T. hamatum* (T-12), *Mucor hiemalis* and *M. circinelloides*.

All eleven species of fungi grew on potato dextrose agar for two weeks at room temperature (27-30^{o}C), then remove fungal structures, especially spores from the fungal colony, then counting the spore number using haemacytometer. The spore suspension of all isolates were then mixed in electrical mixer for 5 minutes before poured into sterilized bottom ash at the rate of 10 petri dishes for each isolate per 100 kg of bottom ash, then incubated for 30 days before used.

Nutrient analysis

The sample of bottom ash and biological ash were sampling taken into plastic bags and brought to laboratory of soil analysis. The soil properties were analyzed for pH, EC, organic matter, K, Ca, Mg, Fe, Mn, Zn, B and Cl. The data were used to compare the nutritional changes between bottom ash and biological ash.

Efficacy of biological ash for the growth of rice var Pathumthani 1

The experiment was done by using Randomized Complete Block Design (RCBD) with four replications. Treatments were as follows:- T1 = non-treated check(control), T2 = apply bottom ash at the rate of 50 kg/rai, T3= apply biological ash at the rate of 25 kg/rai, T4 = apply biological ash at the rate of 50 kg/rai and T5 = apply biological ash at the rate of 75 kg/rai. Clay soil used for the experiment is brought from Ladkrabang rice field, then put into the concrete block which was 0.69 m^2. There were 20 blocks for the experiment and treatments were done as mentioned above. The treatments of biological ash were done by mixing biological ash into soil in each block. All treatments were flooded with water. The 30 days rice seedlings were transplanted into each block with 20 seedlings. The soil samples in each block were sampling taken into plastic bags and brought to laboratory of soil analysis before the experiment and after treatments, then brought to soil analysis. The soil properties were analyzed for pH, EC, organic matter, K, Ca, Mg, Fe, Mn, Zn, B and Cl. Data collection:- plant height (every 15 days), number of tillers, flowering days, number of panicles per tiller, number of harvested panicles, number of grains per panicle and panicle's weight. The data were analyzed statistical analysis and treatment means were compared with Duncan's Multiple Range Test (DMRT) at P = 0.05 and P = 0.01.

Results

Plant Height

The rice growing in the experiment showed significantly different in plant height after 15 d, 30 d and 45 d after transplanting. It was clearly demonstrated that in control plot and ash treatment at 45 d, the plant height were 33.15 cm and 30.46 cm, respectively. When it was highly significant in plant height at 45 d in bio-ash treatments at the rates of 25, 50 and 75 kg/rai

which were 35.59, 35.62 and 39.54 cm, respectively when compared to the ash treatment and non-treated one as seen in Table 1.

Table 1. Plant height of rice from the experimental plots.

Treatments	Plant height (cm)		
	15 d	30 d	45 d
Control	15.25b[1]	19.44b	33.15bc
ash 50 kg/rai	15.84ab	19.66b	30.46c
Bio-ash 25 kg/rai	15.67ab	19.41b	35.59ab
Bio-ash 50 kg/rai	15.29b	19.83ab	35.62ab
Bio-ash 75 kg/rai	16.70a	20.88a	39.54a

[1]Mean of four replications. Means followed by a common letters in each column are not significantly different by DMRT at P=0.05.

Number of plant per tiller

The number of plant per tiller was not significantly different at early stage of 15 d in all treatments. It was clearly shown that the number of tiller at 45 d significantly in bio-ash treatments at the rate of 25 kg/rai, 50 kg/rai and 75 kg/rai which were 6.49, 7.14 and 7.05 plants, respectively when compared to the non-treated one (6.18 plants) and ash treatment (5.55 plants) as seen in Table 2.

Table 2. Number of plant per tiller of rice from the experimental plots.

Treatments	Number of plant per tiller		
	15 d	30 d	45 d
Control	2.38a[1]	5.44ab	6.18bc
ash 50 kg/rai	2.14a	4.93b	5.55c
Bio-ash 25 kg/rai	2.53a	5.53ab	6.49ab
Bio-ash 50 kg/rai	2.01a	5.59ab	7.14a
Bio-ash 75 kg/rai	2.51a	6.27a	7.05a

[1]Mean of four replications. Means followed by a common letters in each column are not significantly different by DMRT at P=0.05.

Number of grain per panicle

The rice growing in the experiment showed significantly different in number of grain per panicle 45 d after transplanting. It was clearly demonstrated that in control plot and ash treatment at 45 d, total number of grain per panicle were 108.50 and 100.75 grains, respectively. But it was highly significant in total number of grains per panicle at 45 d in bio-ash

treatments at the rates of 25, 50 and 75 kg/rai which were 259.50, 227.25 and 265.75 grains, respectively when compared to the ash treatment and non-treated one as seen in Table 3.

Table 3. Number of grain per panicle of rice from the experimental plots.

Treatments	No of grain/panicle		Total
	green	yellow	
Control	0.00b[1]	108.50b[1]	108.50b
ash 50 kg/rai	0.00b	100.75b	100.75b
Bio-ash 25 kg/rai	68.75a	190.25a	259.00a
Bio-ash 50 kg/rai	64.00a	163.25a	227.25a
Bio-ash 75 kg/rai	69.75a	196.00a	265.75a

[1]Mean of four replications. Means followed by a common letters in each column are not significantly different by DMRT at P=0.05.

Grain weight per panicle

The rice growing in the experiment showed significantly different in total grain weight per panicle at 45 d after transplanting. It was clearly demonstrated that in control plot and ash treatment at 45 d, total number of Grain weight per panicle were 152.44 and 111.32 g, respectively. But it was highly significant in total number of total grain weight per panicle at 45 d in bio-ash treatments at the rates of 25, 50 and 75 kg/rai which were 313.57, 299.25 and 351.18 g, respectively when compared to the ash treatment and non-treated one as seen in Table 4.

Number of panicle per tiller

The rice growing in the experiment showed significantly different in number of panicle per tiller at 45 d after transplanting. It was clearly demonstrated that in control plot and ash treatment at 45 d, number of panicle per tiller were 5.50 and 4.56 panicles, respectively. But it was highly significant in number of panicle per tiller at 45 d in bio-ash treatments at the rates of 25, 50 and 75 kg/rai which were 7.39, 7.63 and 7.40 g, respectively when compared to the ash treatment and non-treated one as seen in Table 5.

Table 4. Grain weight per panicle of rice from the experimental plots.

Treatments	Grain weight/ panicle (g)	Grain weight/ panicle (g)	Total (g)	Increase (%)
	green	yellow		
Control	0.00b[1]	152.44b	152.44b	-
ash 50 kg/rai	0.00b	111.32b	111.32b	-
Bio-ash 25 kg/rai	20.66a	292.91a	313.57a	51.38
Bio-ash 50 kg/rai	20.08a	279.17a	299.25a	49.05
Bio-ash 75 kg/rai	35.02a	316.16a	351.18a	56.59

[1]Mean of four replications. Means followed by a common letters in each column are not significantly different by DMRT at P=0.05.

Effect of biological ash for the growth of rice on nutrients

It observed that the biological ash which mixed with 7 species of fungi have produced amylase, cellulose, protease and ligninase as follows:- *Aspergillus sparsus, Chaetomium lucknowense, Achaetomium theilaviopsis, Paecilomyces marquandii, Emericella nidulans, Eurotium herbariorum* and *Arthrobotrys oligospora*, and the other 4 species produced amylase, cellulose and ligninase as follows:-*Trichoderma hamatum, T. hamatum* (T-12), *Mucor hiemalis* and *M. circinelloides* had shown higher EC, organic matter, K, Fe and Cl than the bottom ash alone. It was showed that the pH of bottom ash did not change after mix with the effective fungi as it was 12.48.

Table 5. Number of panicle per tiller of rice from the experimental plots.

Treatments	No of panicle/tiller
Control	5.50b[1]
ash 50 kg/rai	4.56b
Bio-ash 25 kg/rai	7.39a
Bio-ash 50 kg/rai	7.63a
Bio-ash 75 kg/rai	7.40a

[1]Mean of four replications. Means followed by a common letters in each column are not significantly different by DMRT at P=0.05.

The soil planted to rice (soil without bio-ash) in pot experiment showed that the soil pH was 4.2, EC value was 325 and organic matter was 0.67 and and for nutrient analysis showed that P, K, Ca, Mg, Fe, Mn, Zn, B and Cl were 5.70, 94.2, 882, 863, 64.8, 16.2, 1.07, 0.41 and 8.67 ppm, respectively. It was observed that after apply the biological ash to soil planted to rice in pot experiment after 30 day before transplanting, it showed higher in soil pH which

was 5.41, and higher in EC value (7430) and organic matter was increased to 2.95 and increased in P, K, Ca, Mg, Fe, Mn, Zn, B and Cl were 240, 925, 754, 816, 72.2, 17.4, 2.22, 0.63 and 4663 ppm, respectively (Table 6).

It was indicated that the bi-ash has affected to higher soil fertility which increased in plant nutrients available for the growth of rice var Prathumthani 1. This may due to the activities of beneficial fungi added into the bottom ash. It is suggested that the biological ash may possible to develop to be used to increase yield and reduce the chemical use.

Table 6. The nutrient analysis of bottom ash, biological ash, soil planted to rice without biological ash and soil planted to rice with biological ash.

	Units	**Bottom ash**	**Bio-ash**	**Soil without bio-ash**	**Soil treated with bio-ash**
pH, 1:5	-	12.40	12.48	4.20	5.41
EC, 1:5	µS/cm	7760	11030	325	7430
Organic matter	%	0.25	1.39	0.67	2.95
P	ppm	15.2	15.7	5.70	240
K	ppm	189	870	94.2	925
Ca	ppm	67659	67412	882	754
Mg	ppm	877	784	863	816
Fe	ppm	127	160	64.8	72.2
Mn	ppm	-	-	16.2	17.4
Zn	ppm	0.19	0.23	1.07	2.22
B	ppm	51.7	32.6	0.41	0.63
Cl	ppm	198	4037	8.67	4663

References

Bird, J.A., Horwath, W.R., Eagle, A.J. and Kessel, C. (2001). Immobilization of fertilizer nitrogen in rice: effect of straw management practices. Soil Science Society of America Journal 65: 1143-1152.

Cheanrung, J., Aromrat, U. and Na Nakorn, T. (2006). Effect of soil conditioners-tridimite, yod-doi and bunkumthorn for physical and chemical propreties of soil and rice yield. Thai Agricultural Research Journal 24: 153-167.

Eagle, A.J., Bird, J.A., Horwath, W.R., Linquist, B.A., Bouder, A.M., Hill, J.E. and Kessel, C. (2000). Rice yield and nitrogen utilization efficiency under alternative straw management practices. Agronomy Journal 92: 1096-1103.

Eagle, A.J., Bied, J.A., Horwath, W.R., and Kessel, C. (2001). Nitrogen dynamics and fertilizer use efficiency in rice following straw incorporation and winter flooding. Agronomy Journal 93: 1346-1354.

Imiurb, A. (1992). Soil status of the farmers before join the project of soil and fertilizer in 1992. Journal of Land Develpoment 319 (29): 33-40.

Kowapradit, S. (2005). Study of bottom ash in increase the growth of Cassava. Reports of Agricultural Extension Department.
Kumar, K. and Goh, K.M. (2000). Crop residues and management practices: Effects on soil nitrogen dynamics, crop yield and nitrogen recovery. Advances in Agronomy 68: 197-319.

(Received 5 March 2007; accepted 28 May 2007)