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Laboratory Evaluation of Limes against Invasive Swamp Eels, *Monopterus albus* Invading the Ifugao Rice Terraces, Philippines

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Abstract Swamp eels, *Monopterus albus* have caused irreparably damaged rice fields in many parts of the Philippines. The study therefore sought to evaluate the effectiveness of shell limes on the control of swamp eels. The two-factorial Randomized Complete Block Design (RCBD) was used. Factor A included the types of shell lime and Factor B for the various levels of dosages. Sodium Cyanide was used as the control because it is the farmers' practice. Analyses of variance (ANOVA) with SPSS were applied in the treatment of data. Results revealed that there is a significant difference on the effects of treatments. Sodium Cyanide kills *M. albus* at an average time of 15.20 minutes however it is a prohibited chemical. The use of 20 g *Melanoides granifera* shell lime: 500 ml of water or 20 g bivalve clam is also very effective in killing swamp eels at an average time of 60.73 minutes and 57.60 minutes respectively. The shell lime is organically produced, environment friendly and limes increase the fertility of the soil.

Keywords Swamp eels, Shell lime, Rice terraces

1. Introduction

Swamp eels or scientifically called *Monopterus albus* (Zuiew 1793) are commonly known as Asian swamps, rice-paddy and yellow eels. They belong to the sybranchidae fish family that grow as large as 100cm long and weigh as much as a pound. Their body colors range from olive to brown and occasionally light orange on the bottom. Some are colored yellow, black and gold spots as reported on various samples. They breath on air, travel on moist land and survive for weeks without food [3]. By burrowing in moist ground, they can survive for long period without water [1, 5]. As to food, they eat worms, frogs, tadpoles, shrimps, crayfish and other fishes [3].

These swamp eels are nocturnal predators whose eggs are laid in a free-floating nest in shallow water. Male swamp eels guard the nest and young eels [5]. As to sex identity, all young *Monopterus albus* are females but some develop into males when they are adults and can change back to females should female densities are low. Change from one sex to another takes place a year and spawning is up to 1,000 eggs per female in a spawning event.

Researchers and managers believe that dispersal of *Monopterus albus* may be controlled through a combination of electrical barriers, vegetation, removal and trapping. In Florida, agencies are collaborating on implementing an emergency response plan in an effort to eradicate the species or significantly reduce the population in areas adjacent to Everglades National Park to minimize environmental impacts caused by the *Monopterus albus*.

Asian swamp eels are used as fish food [3]. Asians specifically Chinese immigrants are main consumers of swamp eels [5].

In the Philippines, rice scientists are worried about *Monopterus albus* on their potentially damaging impact on rice fields. Farmers observed that these survive long period of drought by burrowing in the moist earth such as dikes and rice fields. The burrowed holes destroy the rice dikes affecting irrigation during the vegetative stage of rice resulting to water loss that affects nutrient management. Farmers first reported the rice paddy eel as a pest to the Bureau of Fisheries and Aquatice Resources (BFAR) in Tuguegarao, Cagayan two years ago complained that these swamp eels were eating fingerlings in fishponds. PhilRice declared then the rice paddy eels as "an indirect pest" during the last dry season of 2010 [4]. Rice farmers in some parts of Nueva Ecija and 2 other provinces reported that *Monopterus albus* appeared in their farms and damaged their irrigation dikes. Other PhilRice stations reported also the presence of *Monopterus albus* in rice farms in Isabela and Negros Occidental. Farmers used pesticide to control but few were found dead [6].

Farmers in Kiangan, Ifugao expressed alarm over the

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quick spread of these eels in their upland rice fields that are contributory to the destruction of the Ifugao Rice Terraces. The emergence of *Monopterus albus* as pest in their upland rice fields worsened the threat from giant earthworms which for years have been a headache for terraces farmers in Ifugao. Farmers from Ifugao said "we are calling on our officials to please help us find means how to get rid of these swamp eels because they pose bigger problems for us".

Objectives of the study

Generally, it sought to manage the *Monopterus albus* pests with the use of environment friendly measures.

Specifically, it aims at:

1. Evaluating the effectiveness of limes in controlling *Monopterus albus*
2. Determining the dosage of the lime that controls *Monopterus albus*
3. Identifying if a significant difference exists on the effects of dosages in terms of limes
4. Identifying if there is a significant difference on the interaction effects of limes and dosages
5. Determining if there exists a significant difference on the effects of lime in terms of the sizes of *Monopterus albus*.

2. Methodology

The research was conducted at the laboratory of IFSU. The shell lime was prepared by burning empty shells and were powdered ready for application. The mixture of shell lime and water was prepared in a beaker following the desired dosages. For every mixture, one eel was placed and observed. The eel is considered dead if it exhibits no movement, the body follows any direction to which the eel is being moved and the body starts to harden.

The use of shell lime natural product in controlling *P. elongata* [2] was the basis of the dosages for this study.

Sodium cyanide was used as the control of the study because it is the chemical being used by the farmers in the place.

Experimental Design

The two-factorial in a Randomized Complete Block Design (RCBD) was used. Factor A holds the limes and factor B the dosages. The blocking factor is day trial.

Factor A – Limes (ABCD)
Factor B – Dosage (10 g, 20 g, 30 g)

Treatments

A1	10 g Sodium cyanide, 500 ml water
A2	20 g Sodium cyanide, 500 ml water
A3	30 g Sodium cyanide, 500 ml water
B1	10 g *Melanoides granifera* lime: 500 ml water
B2	20 g *Melanoides granifera* lime: 500 ml water
B3	30 g *Melanoides granifera* lime: 500 ml water
C1	10 g Bivalve clam lime: 500 ml water
C2	20 g Bivalve clam lime: 500 ml water
C3	30 g Bivalve clam lime: 500 ml water
D1	10 g Golden Apple Snail lime: 500 ml water
D2	20 g Golden Apple Snail: 500 ml water
D3	30 g Golden Apple Snail: 500 ml water

Statistical tools

ANOVA was used to test the significant difference of the effectiveness of the limes, dosages, and interaction effects. To test for the mean comparison of significant difference, DMRT was employed. SAS was used in computing.

3. Results

Effects of Dosages and Lime

Table 1 shows that sodium cyanide (alcampor) has an average killing time of 15.20 minutes across all the dosages of 10 g:500 ml, 20 g:500 ml and 30 g:500 ml for *M. albus* with lengths ranging from 25-35 cm. The *Melanoides granifera* shell lime mixtures killed the *M. albus* across dosages at an average time of 57-60 minutes. This means that the *Melanoides granifera* and bivalve clam take a longer time before the *M. albus* is killed. Both *Melanoides granifera* and bivalve clam have the same killing time. Golden Apple snail has the longest killing time with an average of 97.80 minutes. This shows that golden apple snail has a weaker strength in killing *M. albus*. The appropriate dosage to be used is 20 g of *Melanoides granifera* or bivalve clam: 500 ml water. It is better to use this dosage because lesser time is needed than to use 30 g lime:500 ml water where more lime is to be used and they have the same effects.

Table 1. Average Time of Killing of *M. albus* with Length 25-35cm

Treatment	Dosages			Average Time
	10 g: 500 ml	20 g: 500 ml	30 g: 500 ml	
Sodium Cyanide	23.00 min.	12.40 min.	10.20 min.	15.20^{a} min.
T1 – *Melanoides granifera*	70.60 min.	50.80 min.	60.80 min.	60.73^{b} min.
T2 – Bivalve clam	67.00 min.	56.00 min.	49.80 min.	57.60^{b} min.
T3 – Golden Apple Snail	144.40 min.	80.00 min.	69.00 min.	97.80^{c} min.
Average	76.25^{a} min.	49.80^{b} min.	47.45^{b} min.	

Note: The same letter has no significant difference at 5% level of significance

Table 2 presents that there is significant difference on the effect of lime as supported by the F-value of 141.981 with a P-value of 0.000. This means that the limes have varying degrees of effectiveness when applied to *M.albus*. The F-value of 42.429 and P-value of 0.000 show that there is a significant difference on the effects of dosages. This indicates that different dosages have different effects.

The F-value of 11.842 with a P-value of 0.000 supports the claim that there is interaction effect between the limes and dosages. This indicates that different limes have different effects from one dosage to another.

As shown in table 3, sodium cyanide kills the *M. albus* at an average time of 13.27 minutes. This means that the *M. albus* dies in a very short time. *M. albus* died at an average time of 61.93 minutes when *Melanoides granifera* was applied and at 67.13 minutes when bivalve clam was applied. This reflects that *Melanoides granifera* and bivalve have the same killing time on *M. albus* of about one hour. The *M. albus* died at a longer period compared to that of sodium cyanide. The average killing time when the golden apple snail lime was applied was 96.40 minutes. This means that golden apple snail is the weakest treatment because it killed the *M. albus* with the longest time. The appropriate dosage that kills *M.albus* with length that ranges from 35-45 cm is 20 g lime:500 ml. This is the same dosage with that of *M. albus* with length that range from 25-35 cm. This means that the same dosage can kill *M. albus* with different lengths.

Table 4 illustrates that there is significant difference on the use of lime to *M. albus* with length of 35-45 cm. This means that different kinds of limes have different effects on *M. albus*. There is a significant difference of the effects of various levels of dosages as supported by the F-value of 33.535 and a p-value of 0.000. This indicates that different dosages have different effects.

The P-value of .268 means that there is no interaction effects on the application of lime and the levels of dosages.

Comparison of length

Table 5 shows that there is no significant difference on the effects of lime in terms of the size of *M. albus* as supported by the t-value of 0.293. This explains that the dosage of lime to be used for the sizes of the *M. albus* of 25-35 cm and 35-40 cm is the same. The dosage of lime to be used is 20g shell lime:500 ml water. The choice of lime whether *M. granifera* or bivalve clam depends upon the availability of the lime.

Table 2. ANOVA Table on the time of killing of *M. albus* with length of 25-35 cm

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Lime	51351.000	3	17117.000	141.981	.000
Dosage	10230.433	2	5115.217	42.429	.000
Lime * dosage	8566.100	6	1427.683	11.842	.000
Error	5786.800	48	120.558		
Total	75934.333	59			

Table 3. Average Time of Killing *M. albus* with Length of 35-45 cm

Treatment	Dosages			Average Time
	10 g : 500 ml	20 g : 500 ml	30 g : 500 ml	
Sodium Cyanide	21.6 min.	10.6 min.	7.6 min.	13.27[a] mins
T1 – *Melanoides granifera*	79.4 min.	54.2 min.	52.2 min.	61.93[b] mins
T2 – Bivalve clam	82.6 min.	65.6 min.	53.2 min.	67.13[b] mins
T3 – Golden Apple Snail	113.2 min.	85.8 min.	90.2 min.	96.40[c] mins
Average	74.2[a] min.	54.05[b] min.	50.8[b] min.	

Note: the same letter has no significant difference at 5% level of significance

Table 4. ANOVA Table on the time of killing of *M. albus* with length of 35-45 cm

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Lime	53447.783	3	17815.928	185.905	.000
Dosage	6427.633	2	3213.817	33.535	.000
Lime * dosage	757.567	6	126.261	1.318	.268
Error	4600.000	48	95.833		
Total	65232.983	59			

Table 5. Over all mean and t-value on length of *M. albus*

Length	Mean	Std. Deviation	t-test value	p-value	Remarks
25-35 cm	57.8333	35.87510	0.293	0.770	No difference
35-45 cm	59.6833	33.25122			

4. Conclusions

1. The various types of shell lime are effective in killing *M. albus*.
2. The appropriate dosage that controls *M. albus* at the shortest time aside from the control is 20 g shell lime:500 ml water. The shell lime of *Melanoides granifera* or bivalve clam has the same killing time from the *M. albus*.
3. There is significant difference on the effects of lime and dosage in controlling *M. albus*.
4. There is significant interaction effect on the application of lime and the different dosages.
5. There is no significant difference on the effects of lime as to the various sizes of *M. albus*.

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