Problem of Golden Apple Snail *Pomacea canaliculata* (Lamarck) (Gastropoda: Ampullariidae) in Selected Rice Growing Areas of Myanmar

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Abstract

A survey of 142 farmers was conducted in the seven townships of major rice growing areas of Myanmar to observe the pest status and damages, integrated management practices and farmers' perception of GASs. The farmers were stratified by the level of GAS damage i.e. low, medium and high damage. The majority of interviewed farmers grow the rice by transplanting method (78% of respondents), followed by direct seeding method (14% of respondents) and only 8% of farmers used both methods. The farmers identified that GAS was the key pest on their rice (77%) followed by rice yellow stem borer (3%), rodent (1.7%), BPH (1.7%) and caseworm (0.8%). GASs were firstly aware in Shan State since early 1990s and were introduced as a food item, biological control agent for aquatic weeds. To control the GASs, most of the farmers (89%) used hand picking of snails and egg masses, molluscicides application (39%) followed by the biological (duck herding 32%) and cultural (replanting 32%) measures. Some farmers (17% of respondents) managed the irrigation water into their fields and some farmers (6%) are reluctant to grow rice in their fields as they are afraid of GAS infestation. GAS is clearly the most important problem of rice farmers in the surveyed areas of Myanmar. Farmers from Ayeyarwaddy Delta might suffer more seriously the GASs damages than those of Kayin and Mon States because the farmers from Ayeyarwaddy grow the paddy year round and so many streams and waterways make easy the spread of GASs rapidly and create the breeding grounds for GASs.

Keywords: golden apple snail, rice, farmers' perceptions

Introduction

Apple snails are fresh water snails in the family Ampullariidae and species in this group have globose shells, often with marked dark spiral bands, a whip-like penis, and a penis sheath that is rather broad at the base. The calcareous-shelled eggs are bright pink-reddish and round (Cowie et al. 2006). Many English common names have been used widely for the various species of ampullariids, including "apple snails", "mystery snail", "miracle snail", and "Golden Apple Snail" or "GAS"-"golden" either because of the color of shells, which is sometimes a bright orange-yellow. The term "golden apple snail" has been used widely in Asia to refer to the pest species (Cowie et al. 2006).

GASs are edible and can be consumed both as a human food and as an animal feed because of rich in protein, calcium and phosphorus and energy. Because of this reason, GASs were introduced across the world from Argentina, a native of GAS. The *Pomacea canaliculata* was introduced to Taiwan in the 1980s for commercial production to export (Mochida 1991) and was distributed widely in Asia as a dietary protein supplement, aquarium pet and income earner for rural poor. When market demand for the snail was low, many snail-farming projects were failed and in many occurrences the snails escaped and subsequently became a pest for crops (Naylor 1996).

In its native environment, GAS has not become a major threat to the ecosystem, but it has become an invader in new ecosystems due to its physiological adaptability and ability to move a long distance within a water system. GAS is now a major pest of rice and taro crops in the introduced areas. In the case of Thailand, it seriously damages water cress, *Ipomoea aquatica*, a popular vegetable. It causes not only heavy economic losses but also high costs of control in some Asian countries (Ranamukhaarachchi and Wickramasighe 2006).

Golden apple snails (GAS) are now emerging

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issue because they are invading and infesting rice, tomato, and water cress fields of farmers in Myanmar. It causes the inevitable damages in major rice production areas. Rice crop production cost built up to double because of molluscicides and replanting in missing hills caused by GAS's damages. Some farmers lost 100% of their crops. Some farmers are reluctant to grow rice in all their fields as they are afraid of GAS infestation. They also do not know how to control GAS effectively. Some farmers mainly rely on commercially available synthetic molluscicides for the immediate control of GAS in the lowland rice fields, without considering the toxic hazards to themselves and non -target organisms and serious economic, social, and environmental impacts, biodiversity loss, and health hazards to rice farming communities.

GASs are quickly spreading from township to township and causing more and more damages from year to year. GAS problems are nation-wide problems that urgently needed to take actions. However few researches have been carried out over a decade ago but no updated research and information about GAS. Therefore it is absolutely necessary to do research in all fields about GAS. This research was conducted to know the pest status and damage of GAS in selected rice growing areas of Myanmar.

Materials and Methods

The farmer household survey was conducted in seven townships (Dedaye, Pyapon, Kyaiklat from Ayeyarwaddy Region, Pha-An, Hlaing Bwe from Kayin State, and Chaung Zone from Mon State, Nyaung Shwe (Inle lake) from Southern Shan State) to know the pest status and damage of GAS during May and October, 2015 (Figure -1). The farmers from these seven townships are currently faced with serious GAS problems and yield losses. It demands urgent research and management programs to tackle the problems.

The survey interviewed four plant protection officers of Department of Agriculture (DOA), three township managers from Farm Advisory Services Team, Proximity Designs, NGO which is working in those areas to overview the townships conditions and 15 village leaders to check the villages conditions. The 120 farmers were randomly selected based on the level of GAS infestation- high (70-100% acres infested), moderate (40-69% acres infested) and low (0-39% acre infested) from each township. This survey interviewed a total number of 142 respondents.

The survey questionnaire was prepared based on questionnaire for research on farmers' knowledge, attitudes, and practices in pest management developed by Rice IPM Network, International Rice Research Institute (IRRI), Philippines (Escalada and Heong 1997).

Figure – 1: Survey Areas for golden apple snail pest status and damage in selected rice growing areas;(1) Dedaye, Kyaik Latt and Pyapon townships from Ayeyarwaddy Region, (2) Chaung Zon township from Mon State, (3) Hpa-An and Hlaing Bwe townships from Kayin State and (4) Inle Lake from Southen Shan State.

The survey questionnaire comprised of 36 questions and subdivided into three main sections; (1) the farmer characteristics and farming practices, (2) the pest management practices and GAS problems and (3)

Results

1. Characteristics of farmers and their farms

The mean age of the interviewed farmers was 49.0 years (n=120) and their average landholding was 9.38 acres ranging from 0.5 acres to 49.20 acres. The majority of interviewed farmers grow the rice by transplanting method (78%, n=120), followed by direct seeding method (14%, n=120) and only 8% of farmers used both methods. The most commonly grown rice varieties in those areas were Paw San Bay-Gyar, Hnan-Gar, and Ma-Naw-Pyat in monsoon season and Shwe-up, Thee-Htet-Yin and 90-days varieties in summer season. Four types of cropping patterns were recorded in this study: (1) monsoon rice – summer rice (44%), (2) monsoon rice only (27%), (3) summer rice only (24%), and (4) monsoon rice - legumes (5%). The average rice yields of last three years (2012-2014) were 2.29 tons per ha and 3.856 tons per ha in monsoon and summer seasons respectively.

2. Pests on Rice Crop:

The farmers identified that GAS was the key pest on their rice (77%) followed by rice yellow stem borer (3%), rodent (1.7%), BPH (1.7%) and caseworm (0.8%). Moreover irrigation problems (insufficient water and flooding 16%) were other major causes to decrease their yields.

3. Golden Apple Snail and its management

3.1. History of GAS spread in Myanmar

According to Khin et al. 2002, GASs were firstly aware in Shan State since early 1990s. However there were no specific damaged areas by the GASs (Htwe et al. 2016). The ways and causes of GASs' spread were observed in the surveyed areas during the studied periods. GASs are spread to the Kayin State by river Thanlwin flooding since 2007. GASs continued to spread to Hlaing Bwe township in 2010 and then to Chaung Zon township of Mon State in 2012 and 2013 due to river Thanlwin flooding. In the case of Inle Lake, GASs were deliberately introduced by human in order to control biologically the aquatic weeds of the lake since 2010. In the Ayeyarwaddy Delta, especially Dedaye Township, the GASs were introduced as a food item by the human since 2012. Now GASs continued to spread and invaded other townships such as Kyaik Latt, Pyapon, Bogale, Mawgyun and Wakema townships.

3.2. GAS outbreaks

When the presence of GAS was aware for the first time in a place, there were neither substancial damages nor losses caused by them. In Kayin State, initial infestation of GAS in the rice fields was observed by the year of 2010 and outbreaks were recorded in 2012 and 2013. In Chaung Zon Township of Mon State, the most serious outbreak of GASs was recorded in 2014 because of river Thanlwin flooding in 2013. GASs invaded and seriously infested the rice fields from Inle Lake, Southern Shan State in 2011 and 2012 because the farmers did not know how to control GASs and its high reproductive rate. The serious damages of GASs were recorded in 2014 and 2015 in Dedaye, Kyaik Latt and

Table-1: Responses of farmers to questions relating to the IPM of GAS

Can GAS infest both Growing Methods (Transplant or Direct Seeding)?		Can GAS infest all rice varieties (no preference)?		Can GAS infest when the fields are drained out?			Can GAS eat other plants besides rice?			Ducks eat GAS?			What do you think whether GAS is edible or not?			Do you eat GAS?	
Yes	No	Yes	No	Yes	No	Maybe	Yes	No	Maybe	Yes	No	Maybe	Yes	No	Maybe	Yes	No
5	10	11	4	3	10	2	7	5	4	15			12	2	1	5	10
13	2	14	1		17		16		1	17			14	1	1	3	14
15	0	11	4		14	1	12		3	15			14		1	3	12
15	3	13	5	2	16		16	1		18			17		1	11	7
9	1	8	2		8	2	4	5	1	6	3	1	9		1	6	4
11	4	8	7	3	9		9	1	1	11	1		9	3	2	5	9
29	0	17	6	4	24		22	3	3	23	1	4	14	12	2		28
97	20	82	29	12	98	5	86	15	13	105	5	5	89	18	9	33	84
83%	17%	74%	26%	10%	85%	4%	75%	13%	11%	91%	4%	4%	77%	16%	8%	28%	72%

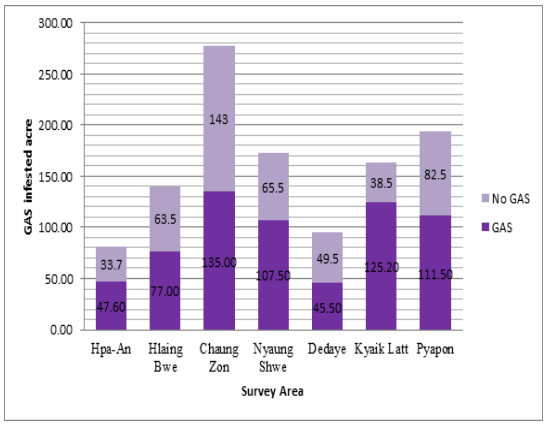

Figure -2: GASs infestation in rice field in survey

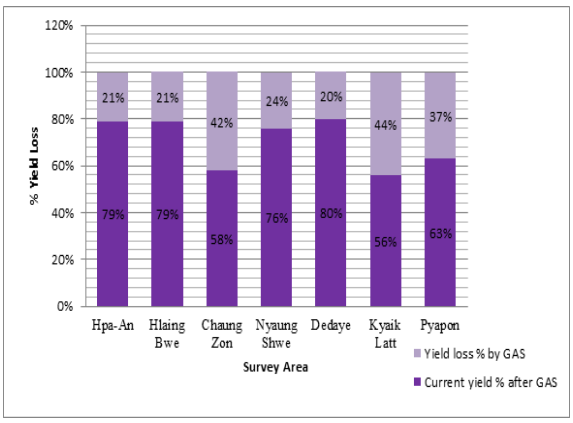

Figure -3: Comparison of percentage of yield loss caused by GAS in the survey areas

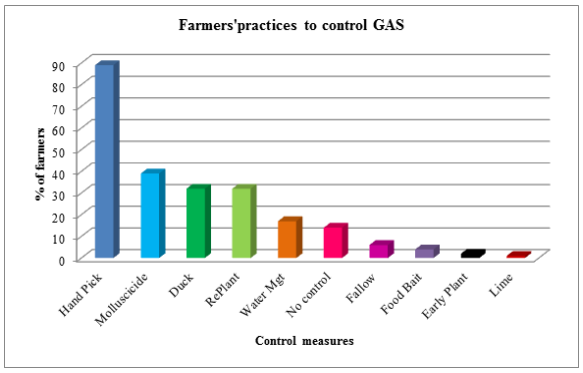

Figure - 4: Farmers practices to control the GASs in the survey areas

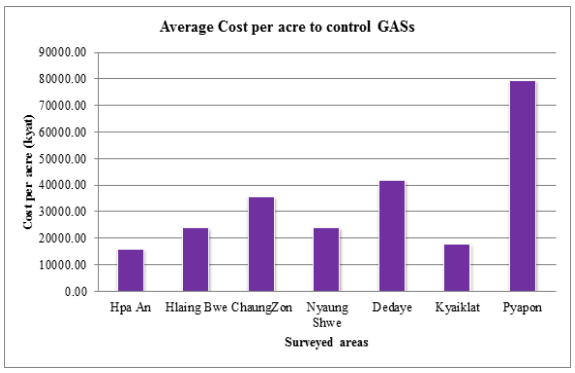

Figure -5: Comparison of average cost per acre to control GAS in the survey areas

Pyapon townships of Ayeyarwaddy Delta.

3.3. GAS infestation on Rice

According to the survey results, GASs are invading more than 60% of rice field in Ayeyarwaddy Delta and Inle Lake and 48% Chaung Zon township of Mon State and Hpa-An and Hliang Bwe townships of Kayin State (Figure-2). GAS infestation resulted in (average) yield loss of 20 - 44% in rice in all townships (Figure- 3).

Farmers (n=82) observed that GASs infested and caused large damages on every rice variety and there was no preference among rice varieties. However few farmers (n=29) believed that certain local varieties such as "Shwe Up" from Inle Lake and "Manaw Pyat" from Kayin State are more severely infested compared to others rice varieties. GAS's damages were not different (n=97) among growing methods (transplanting or direct seeding) but more severe in monsoon rice than in summer rice (Table-1).

3.4. Farmers' practices to control GAS

According to interviewing results of 120 farmers, most of the farmers (89%) used hand picking of snails and egg masses to control GAS. Molluscicides application (39%) was the second most popular method in the survey areas followed by the biological (duck herding 32%) and cultural (replanting 32%) measures. Some farmers (17% of respondents) managed the irrigation water into their fields and some farmers (6%) are reluctant to grow rice in their fields as they are afraid of GAS infestation. Some farmers (14%) did not control the GAS because they do not know how to control GAS and they think that GAS cannot be controlled (Figure-4).

3.5. Cost to control GAS

Rice production cost built up to double because of GAS's damages although some farmers did not suffer yield losses. This study recorded the costs of control per acre only for top three control measures, i.e. cost for molluscicides, cost for hand pickings,

and cost for replanting. The maximum cost per acre for GAS control was 135,000 kyats from Chaung Zon Township. However the maximum township average cost per acre to control GAS was 79,500 kyats which are recorded in the Pyapon Township (Figure-5).

3.6. Farmers' knowledge on GAS and its integrated management

Farmers believed that GAS can infest both transplanting and direct seeding methods (83%) and some farmers (17%) said that GAS cannot infest if rice is grown by transplanting method because the rice plants are tolerant enough to GAS damage. Farmers observed that GAS can infest all rice varieties and no variety preference (74%) but some farmers believed that GAS infests the rice varieties which have soft culms and aroma. The majority of interviewed farmers (85%) noticed that GAS cannot infest the crop when the fields are well-drained. Some farmers said that GAS can also infest the rice even if the field water drains out (10%) but a few of them do not know for sure (5%). Seventy five percent of the respondents noticed that GAS eat other plants such as weeds, aquatic soft plants but some farmers (13%) disagree to that statement and some of them (11%) answered that GAS may eat the other plants besides rice plants. Although farmers observed that ducks eat small snails (91%), very few of them do not know whether ducks eat snails or not (4%) but some farmers (4%) said that ducks cannot eat GASs. Most farmers believed that GASs are edible (77%) and they eat GASs sometimes (28%). The majority of them dare not to eat snails (72%) because they do not think that GASs are edible (16%) and snails cause irritation and high blood pressure (Table-1).

Discussion

GAS is the most important problem of rice farmers in the surveyed areas of Myanmar. Flooding the crop lands enhanced damage potential of GASs than that of GAS alone. In the surveyed areas, flooding is the second most important constraint of farmers in their rice production not only by the direct crop damage but also by supporting GAS's damage indirectly.

In Myanmar, the first record of GAS presence was in the northern Shan State in the early1990s but there were no significant damage (Htwe et al. 2016). A few years later after the first infestation, some experiments were conducted for their control (Khin et al. 2002). GASs spread to the Hpa-An and Hlaing Bwe townships from Kayin State and then to Chaung Zon township of Mon State by the river Thanlwin flooding since 2007. Therefore GASs are called "2007 snails" in some of survey areas from Hpa-An township. In the case of Inle Lake, GASs were deliberately introduced by human in order to biologically control the aquatic weeds of the lake since 2010. Then GASs spread to the rice fields by flooding during monsoon season. In the Ayeyarwaddy Delta, especially Dedaye Township, the GASs were introduced as a food item since 2012 by migrant workers from Myanmar-Thailand border. Now GASs continued to spread and invaded other townships such as Kyaik Latt, Pyapon, Bogale, Mawgyun and Wakema townships and Kun Gyan Kone township from Yangon region because the rivers and streams of Ayeyarwaddy Delta are main distributing ways for GAS easily.

Farmers from Kayin and Mon States pointed out three main causes of GASs outbreaks as river Than Lwin flooding, high reproduction of GASs and lack of knowledge to control them. Some farmers noticed that GASs infested more seriously and caused sunstantial damages in a year after the river Than Lwin flooding. In the case of Ayeyarwaddy Delta, the problem of GASs became severe and causing more and more damages year by year because the farmers cannot manage the water entering into their fields. The rice fields are completely flooded by high tidal water twice a month during monsoon season. Even if the farmers did control, GASs will be recruited again into their fields by tidal water.

Although GASs have preference among food plants, they are generalist and indiscriminate feeders not only in terms of plant species but also parts of the plants (Ranamukhaarachchi and Sariyarni 2006). Some farmers observed that certain local varieties such as "Shwe Up" from Inle Lake and "Manaw Pyat" from Kayin State suffered more damage than others because these rice varieties have soft culms and aroma. However, most of the farm-

ers believed that GAS can cause damages at the early stages of plant growth in both transplanting and direct seeding but they can cause more severe damage in monsoon rice than summer rice due to difficulty of water management in the monsoon season.

In order to control the GASs, hand picking method was the most available and affordable although it cannot give the great satisfaction. Some of the farmers applied molluscicides and other pesticides such as Furadan 3G. However these pesticides cannot solve the GAS problems as the water in their paddy fields could not be managed properly. Some of the farmers applied integrated snail management with the combination of hand picking of snails and eggs, herding ducks, and water management. A few of the interviewed farmers did not use any control measures at all but they replaced the missing hills caused by GASs many times. Therefore the cultivation again and again built up the cost of their rice production. Unfortunately some farmers cannot replant due to lack of seed source, too late for growing time, and shortage of capital to replace the missing hills.

Most of the farmers have knowledge on the behavior of GAS and concepts of IPM such as older paddy seedlings tolerant to GAS's damage, GASs cannot damage the rice plants when the fields are completely drained out, GASs eat other aquatic plant besides rice, the ducks eat the GASs and GASs are edible. However they cannot apply the knowledge practically to control GASs. Even though they know that GASs cannot cause the severe damage when the fields are drained out, they cannot drain out the water from their fields. They did not use the other plants or plant parts to attract the GASs in order to suit for hand picking. Moreover they did not try to use the older rice seedlings to reduce the GASs damage. Because they worried and exhausted to kill the GASs immediately by using poisons in order to protect their crops and investments.

In Mon and Kayin States, staff from Department of Agriculture shared and disseminated techniques about the GASs and control measures but not enough. They organized campaigns for the collection of snails and eggs. Farming system experiments concerning GAS controls were conducted in the farmers' fields from the Ayeyarwaddy Delta by the Farm Advisory Services Team, Proximity Design, an NGO which is working and helping rice farmers over 20 townships across Myanmar.

Conclusion

Golden apple snails (GAS) are now emerging issue to take action nationally because they are invading and infesting rice, tomato, and water cress fields of farmers in Myanmar. GASs are present in the Ayeyarwaddy, Yangon, Bago, Mandalay Regions and Mon, Kayin, Shan and Kachin States.

It causes the inevitable damages in rice production areas in Kayin, Mon, Shan States and Ayeyarwaddy Region. In Ayeyarwaddy region, the rice bowl of Myanmar, GAS problems have been reported in Dedaye Township since 2012. Now the problems spread to other townships such as Pyapon, Kyaiklatt, Bogale, Mawgyun, Wakema and Maubin Townships. Farmers from Ayeyarwaddy Delta might suffer more seriously the GASs damages than farmers from Kayin and Mon because the farmers from Ayeyarwaddy grow the paddy year round and so many streams and waterways make easy to spread GASs quickly and create the breeding grounds for GASs. Therefore it is absolutely necessary to do research in all fields about GAS.

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