Management of Golden apple Snails (Pomacea spp.)

1. Introduction

Golden apple snails (*Pomacea spp*.) originated from Central and South America was purposely introduced into Chinese Taiwan during 1979-1981 for culinary purposes. From Taiwan, it was introduced to other countries in Asia and South East Asia (Naylor, 1996) for the same reason. It was so popular such that Kenji (2003) reported that it was fashionable to raise this snail species as human food, such that at one time there were 495 sites in 35 prefectures doing so. Within a short time after its introduction, the snails became invasive and spread rapidly after people transport it from one pond to the other for the purpose of rearing it for local and export culinary market. However, due to unacceptable taste and due to unexpectedly disappearing escargot market, the snails were abandoned and escaped to streams, ponds, marshes, lakes, abandoned tin mines and rice areas.

In Malaysia, golden apple snails (GAS) was first detected in the fishponds at Puchong and Subang, Selangor, in September 1991. The snail species found at Puchong was identified as *Pomacea insularum*, while that found at Subang was identified as *P. canaliculata* (Chang 1992, Jambari 1992, Mat Hassan and Abdul Kadir 2002). In the Philippines, Rice IPM Network (1991) reported that in 1991, 400,000 ha or almost 26% of the total irrigated rice areas were infested with the GAS. By 2003, It was reported that 1.4 million ha out of 3 million ha of ricelands was infested (Applesnail 2003). However, over the years, the farmers in the Philippines had utilized the golden apple snails as a feedstuff for their ducks reared for the "balut" industry. And now, golden apple snails are not considered as rice pest in the Philippines. In Malaysia, it was reported that the area infested by the golden apple snails was less than 4,000 ha per season since 1996 (Anon, 2012).

2. Identification of Pomacea spp.

In Malaysia, at least two species of golden apple snails were reported present i.e. *Pomacea canaliculata* (Fig. 1) and *Pomacea insularum (Fig. 2)*. However there are no definitive physical features that can be used to differentiate between the two. However, these two Pomacea species could be differentiated quite confidently with the two local apple snails, *Pila ampullacea (Fig. 3)* and *Pila scutata (Fig. 4)* as shown in Table 1.

Fig. 1. *Pomacea insularum*



Fig. 2. *Pomacea canaliculata*



Fig. 3. *Pila ampullacea*



Fig. 4. *Pila scutata*



Table 1. Physical characters differentiating Pila spp. With Pomacea spp.

	Egg color	operculum	umbilicus	suture
Pila ampullacea	Light brown	calcified	Not pronounced	flat
Pila scutata	white	calcified	Not pronounced	flat
Pomacea canaliculata *Pomacea insularum*	pink	horny	Deep & large	<90^{o} - deep

3. Biology and Ecology

GAS is extremely polyphagus, feeding on vegetative and animal matter, including detritus (Estebenet and Martin, 2002). The biology of the golden apple snails, *P. canaliculata* was summarized by Andrew (1964), Mochida (1991) and Estebenet and Cazzaniga (1992). The female snail oviposit egg masses as early as one day after copulation. Ovipositio normally occurs at night. One female can produce between 200-700 eggs per week and up to more than 8,000 eggs per year depending on the size of the snail. Eggs (Fig. 5) masses were normally laid out of water, more than 20cm above the waterline on any objects including rice plants, stakes, wall, floating objects etc. Eggs will start hatching 10-14 days after being oviposited with almost 90% hatchability success. The juvenile snails start crawling when they reach 2-5 mm in size and they start feeding on detritus and soft aquatic plants (Guerrero 1991). They can grow very fast and mature sexually in a short period of time. The life cycle (Fig. 6) lasts for 60 days but the snail can live up to 3 years (Applesnail 2003). Depending on food

abundance and availability, the juveniles can become adults within 25 days and become sexually matured within 60 days (Candida and Magsino 2006).

Fig. 5. An egg mass of *Pomacea spp.*



Fig. 6. Life cycle of *Pomacea spp.*



4. Damage Caused by Golden Apple snails

Juveniles and adults golden apple snails caused damage to rice seedlings by consuming the germinating seedling, the tender tissues at the base of rice seedlings and feed on the newly transplanted rice (Halwart 1994). The critical stage of GAS infestation on the wet seeding

of pre-germinated seeds are about 30 – 40 days. After 40 days, infestation by apple snails on the rice plants is not considered destructive because the snails would not be able to feed on the hardy rice plants anymore. Similarly, planting of older transplanted seedlings (25-30 days old seedlings) could save crop from attack. However, In Malaysia, where younger seedlings of less than 15 days old are used, the transplanted seedlings will still be subjected to snail attacks. In transplanted rice, the mobility of GAS as well as its feeding capability can be restricted by maintaining low water level of 2-3 cm deep when the rice field is flooded 3 days after transplanting. Furthermore, alternating flooding and drying will greatly reduce the mobility and feeding by the snails (Ranamukhaarachchi and Wickramasinghe 2006).

Proper water management after sowing or the pre-germinated seeds is broadcasting is also highly effective in managing damage by snails attack in wet seedings . Draining off water before broadcasting the pre-germinated seeds and reintroduce water into the rice field after about 10 days will reduce snail infestation when snails were effectively control before seeding and snails were prevented entry into the rice field by installing traps or strainers at all water inlet points.

Studies conducted by the Department of Tuaran Agriculture Research Center, Sabah showed that the damage potential of GAS depends on water depth, seedling age, and pest density, in that order (Teo 2002). Damage to direct seeded rice and to transplanted 21-, 30-, and 40-days old seedlings were 100%, 82.9%, 59.7% and 46% respectively at >5cm water depth. Insignificant damage was experienced at water level <5cm deep. When water level was reduced to the saturated soil moisture level, insignificant damage occurred to direct seeded and 21 days old transplanted seedlings even at a pest density of >5 snails/m^2.

Severe damage to the rice plants (Fig. 6a) occur when water level in the rice field could not be controlled effectively, land was not properly leveled and control measures undertaken were not effective.

Fig. 6a. Severe damage of rice plants caused by Pomacea spp.



5. GAS management Guidelines

The factors that influence the density of the snail population in the rice fields and the effectiveness of of control strategies need to be understood. Some of this factors are shown in Fig. 7a. Farmers as well as extension agents should be aware that only active GAS in the rice fields can be handpicked, control by ducks or fishes, or killed by molluscicides, while those that are aestivating in the soil cannot (Yahaya et al. 2006). Therefore, the rice field should be flooded 2 days before molluscicide treatment to encourage the aestivating snails to become active and came out of aestivation. Similarly, it should be noted that installing strainers or traps at all water inlets into the rice field are essential in preventing snails intrusion after treatments in the rice field has been conducted.

Fig. 7a. Factors influencing snail management in the rice fields.

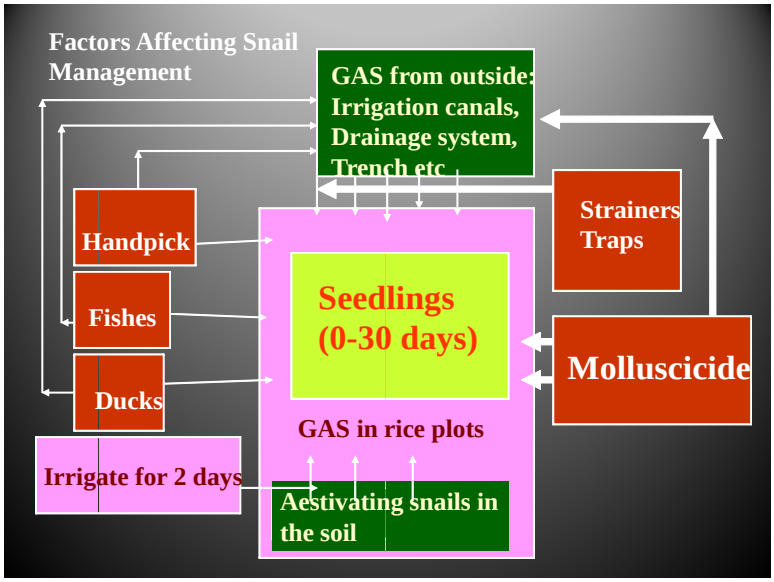


Fig. 7b. Screens and traps at water inlets ito rice field.



6. Management Options

Management of the golden apple snails may require the integration of two or more control strategies. Most of the control measures and management practices have been tried (Dela Cruz et al. 2003, Wada 2004); they have found that snails can be controlled by mechanical, biological and chemical measures at different stages of rice cultivation.

6.1. Cultural/Mechanical Control

Various cultural control methods have been practiced in Asian countries. This include various types of direct seeding methods i.e wet seeding and dry seeding. It has been shown that dry seeding could result in very low damage caused by snails. However it is not frequently practiced due mainly to weed problems and formation of cracks on the bunds leading to water leakage during and after irrigation. Water management in the wet seeding technique could also being practiced effectively to reduce seedling damages during the critical stages as discussed above.

Handpicking of snails during the period after water is drained off the rice field (about 90 days after sowing) to the final harrowing for the succeeding crops reduce snail population threat for the next crop (Wada 2004). Hand picking of snails can be facilitated by attracting the snails using the various kinds of herbal attractants such as tapioca leaves, water convolvulus leaves, banana stem, *Pisonia alba* leaves etc. (Fig. 8). Collecting and destroying of egg masses in the field is another method that could be used for controlling GAS. Erecting of bamboo stakes or any wooden stakes can stimulate and attract the snail to lay their eggs on the stakes (Fig. 9). Egg masses oviposited on the stakes are easily visible, collected and destroyed.

6.2 Habitat modification

Habitat modification involved constructuring of small canals in the rice field about 25cm wide and 5 cm deep along the edges or perimeter of direct seeded rice plots. When water is drained off the plot, water will remain in the side or perimeter drains thus attracting the snails into the drain that can be handpicked or physically removed with ease. Again, when water is drained off the plot before harvesting, snails will again collect in the side or perimeter drains. Physical removal or even molluscicide application could be applied in the drains.

Another modification to the existing plot layout, is whereby small drains can be constructed so that water from the irrigation canal will be allowed to enter to the plot through the drain. Four inch diameter PVC can be placed between the drain and the plot so that netting or strainers could be installed to screen out snails from entering the rice plots (Fig.10a and 10b).

Fig. 8. Use of baits to facilitate hand picking of snails



Fig. 9. Wooden stakes erected to facilitate physical removal of egg masses.



Fig. 10a. Construction of drains between 2 plot facilitate snail management



Fig. 10b. Perimeter drains facilitate snail management



6.3 Biological Control

Herding of ducks through the rice fields immediately after harvest until before sowing or broadcasting of pre-germinated seeds can help reduce the snail population. In tranplanted rice planting, ducks could be allowed to enter the rice plots 30 – 35 days after transplanting. Ducks can be left in the rice field until water is drained off the field at 85-90 Days after transplanted. Khaki Campbell breed of ducks are preferred due to its prolific egg-laying characteristics. 5-10 ducks per hectare were recommended

Fig. 11. Duck pasturing is one of biological control option



6.3.1 Biological molluscicides

Although a number of biological molluscicides has been tested, not may has shown great potential to be commercialized. One of the first biological molluscicides used to control the golden apple snail was the tea-seed cake. Tea-seed cake was mainly used to clean off ponds from predatory fishes for prawn culture. In Malaysia, it was never registered for use as a molluscicide. However it was widely used during the early stages of the snail introduction into the country basically because no other products were available then to control golden apple snails. The recommended rate of use was 51kg/ha. The raw tea-seed cake was recommended to be soaked in water overnight before it is applied into the rice field. Treated water is allowed to stand in the plot for at least 3 days before the water is allowed to be drained off. It was estimated that by the time the treated water is released into the drainage system, it is no more toxic and will have the least detrimental effects on aquatic organisms in the drainage system. Currently, tea-seed cake is not being used anymore due to toxic effects to the applicators.

6.4. Chemical control

In Malaysia, only niclosamide and metaldehyde are registered for GAS control. Bayluscide (niclosamide ethanolamide) a moilluscicide pecific for controlling aquatic snails is recommended to be used at the rate of 315g ha at volume of spray of 180L/ha. There is s need to flood the rice field prior to molluscicide application to stimulate aestivating snails in the soil to be active and move to the soil surface. After application, water should be kept in the rice field for at least 2-3 days before it is drained out. Proper usage can reduce detrimental environmental impacts

Metaldehyde, on the other hand is available in granulated forms as well as in liquid formulation. In granulated form, it needs to be broadcasted evenly in the rice plots. During the molluscicide application, water level in the plot is required to be maintained at 2-3 cm deep. At snail density of less than 5 snails/m^2, the recommended rate of use is 4.5 kg/ha (5% metaldehyde). Higher rates of 14 kg/ha is recommended at snail density of more than 5/m^2.

It is quite a common practice for farmers in some Asian countries to use non-registered molluscicides to control snail infestation. Although these molluscicides are highly effective and very cheap to buy, they can cause severe environmental impact on species diversity, health hazards to the farmers and contributed to the long term destruction of ecological balance of

the rice ecosystem. A more prudent approach to snail management need to be formulated so that a sustainable and environmentally friendly snail management options are made available to the farmers.

7. Field Operation

An example of field operation in managing the golden apple snail under wet direct seeding technique is shown in the Table 2.

Table 2. Field operation in managing GAS under wet direct seeding technique.

Field Operation

Days after sowing	Activity	Comments
(-30) - (-3)	Collect and destroy snails and egg masses or herd ducks into rice field. Put up strainers at all water inlets into the rice field Flooding the field 2-3 days before molluscicides are applied	Conducted in rice fields and irrigation system. Collection of snails can be facilitated with use of herbage attractants Nets or traps will prevent snails in irrigation canals from entering the rice field Stimulate snails aestivating in the soil to surface
-2	Recommended molluscicide such as niclosamide (315g/ha) or metaldehyde (14kg/ha) applied and water in ricefield retained for 2 days before being drained out. Water level maintained at 2-5 cm deep Construct perimeter or side drains after draining the water out.	Mollucicide is sprayed or broadcast evenly to obtain optimum control Perimeter drains should be about 25cm wide and 10 cm deep to trap snails after water is drained out.
0 - 7	Apply recommended molluscicide in drains and puddles if snails are detected.	Spot applications to control snails not killed from previous treatments.
7 - 10	Check that strainers and traps are working properly	Prevent snails entry from outside
> 40	Control measures are not necessary even if snails are detected in the rice field	Snails presence after the fourth or sixth week after sowing did not pose threat to the seedlings
> 90	Collect and destroy all snails and egg masses collected in the rice field especially in the perimeter drain	After water is drained out, snails will collect in the perimeter drain
At harvest	Ensure harvesters are snail free	Prevent spread and dispersal of snails
After harvest	Herd ducks into the rice field	Ducks will reduce snail population in the rice field

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