Management of Golden Apple Snails

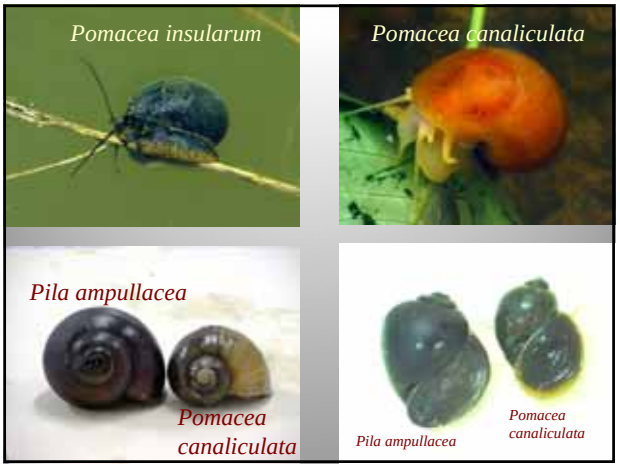
YAHAYA HUSSAIN

REGIONAL WORKSHOP ON SPREAD PREVENTION AND CONTROL OF APPLE SNAIL (*Pomacea* spp.) IN RICE
3-7 December 2012 Kuala Lumpur, Malaysia

Introduction

- Golden Apple Snails
  - *Pomacea canaliculata*
  - *Pomacea insularum*
  - Originated from Central & South America
  - Introduced into Chinese Taiwan during1979-1981 for culinary purposes.
  - Indigenous species of apple snails were not known to cause damage to rice seedlings
  - Some of the indigenous species snails were also used as food by the locals.

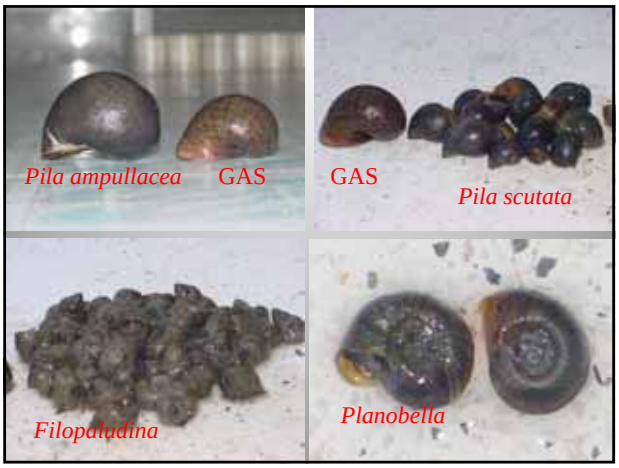
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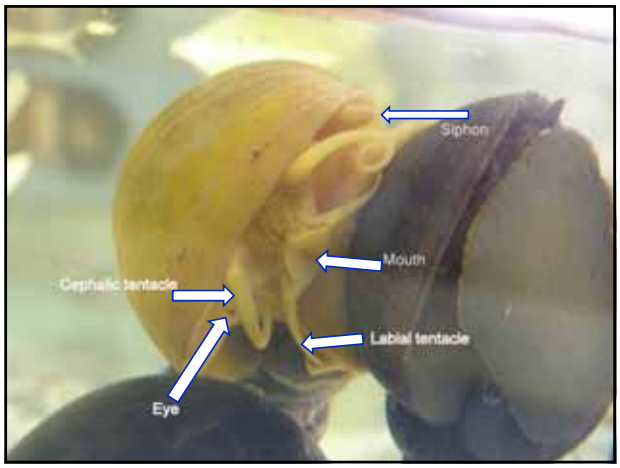












Egg color and shell characteristics

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

GAS Background

	Cambod	Indonesi	Thailand	Vietnam	Phil.	Laos	Malaysia
Historical Profile							
Year Introduced	1995	1986	1981	1982	1982	1989	1991?
Year reported as rice pest	2001	2002	2000	1988	1986	1993	1991
Purpose of Introduction							
Pet	+	+	+	-	+	+	+
Food	+	-	+	+	+	+	+
Revenue	+	+	+	+	+	+	+
Other purposes	-	-	-	-	+	-	-
Species Determination							
P. canaliculata	+	+	+	?	+	?	+
P. insularum	+	+	+	?	?	?	+
Other spp. (*Pila spp*)	+	+	?	?	+	?	+

PATH OF GAS INTRODUCTION IN ASIA



Crop Damage

- Damage caused by GAS is related to seedling age, snail size, snail density and water depth in the rice field
- Snails smaller than 10mm shell height normally do not feed on rice seedlings.
- Damage occurred when snail forage on germinating seeds and/or rice seedling up to about 40 days after sowing
- One snail about 2 cm shell height can damage 1 msq seedlings within a week.
- At density of 5 snails per msq, 100% seedling losses can occur when water level is > 5cm deep.

Severe damage occurred when:

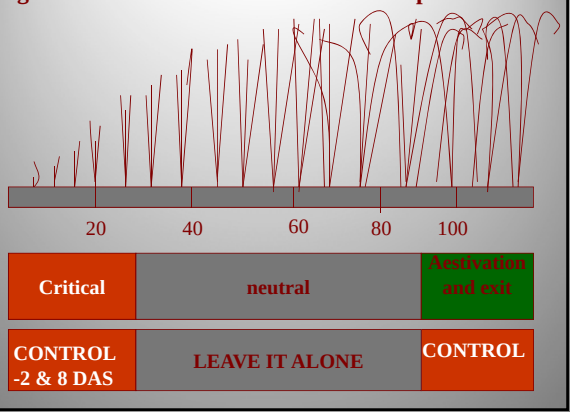
- Water level could not be controlled effectively
- Land not properly leveled
- Control measures not effective

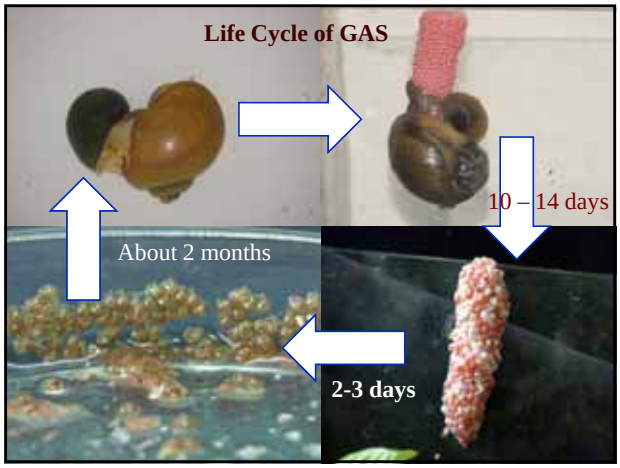
Critical stage of infestation

Critical stage of GAS infestation is only limited to about 4-5 weeks after sowing

After the critical stage, GAS is no longer considered a problem . Instead it could be beneficial for weed control in the rice field. However if left uncontrolled after the critical stage, it will posed more serious threat the following planting season.

Stages of Snails Infestation of the Rice Crops



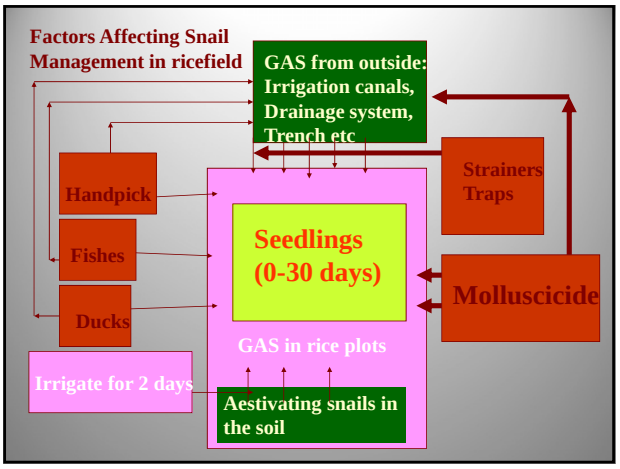


Integrated Pest management

- Understand the biology and ecology of GAS
- Integrate the various control strategies to obtain the most effective control.
- Accept the fact that GAS has been naturalised
- Mitigate spread through movement of combine harvesters and other machineries
- Identify factors that will facilitate GAS management.
- Create awareness and educate the farmers and extension agents
- Integrate and organize concerted efforts by all parties involved

IPM of GAS

- No single method is effective in achieving desired level of snail control.
- Management of GAS may conflict with the management of weedy rice and vice versa.
- Involve time, labour and additional cost



Control Strategies

Integrated Pest Management

- Physical Control
- Cultural Control
- Biological Molluscicide
- Habitat Modification
- Biological Control
- Chemical Control

Physical control

- Handpicking of egg masses and adult snails
- Use traps @ strainers at all water inlets into the field
- baits – all kind of herbage baits such as water convolvulus, manihot leaves or grasses etc.
- Put up sticks or bamboo for snail to lay eggs
- Community efforts or gotong royong
  - Bounty for snails and egg masses





- Traps (all kinds) can be placed at water inlets to prevent snail entry into the rice field



Strainers or nets installed at irrigation canals gates to prevent snail entry into the rice field.







Nets installed at the inlet hose when pumping water from snail contaminated drainage canals.







- Baits can be used to concentrate snails for physical removal or confining pesticide application to specific area
- Installing bamboo stakes or sticks to facilitate collection of egg masses







- All kind of baits can be used to attract and concentrate GAS for easy handpicking/physical removal.







Public awareness campaign by organizing competition and collection of adult snails and egg masses.







Cultural control

- Land leveling – ensure field is flat with no puddles. Serious damage normally occurred in puddles and water standing areas after seeding.
- Water level after land smoothing should not be less than 3 cm. At water level less than 3 cm, snails will bury itself into the soil esp. on hot sunny days.
- Practice wet seeding – could reduce infestation. Water reintroduced into the field after 7-10 days after seeding.
- Proper and complete burning of rice stubbles after harvest could help in reducing snail population in the field.
- Revert to mechanical transplanting/transplanting

Land Preparation

- Proper plough and land leveling could reduce snails population in the soil
- Avoid creating puddles in the rice field





Control GAS by reverting to transplanting either manually or using mechanical transplanter





Transplanting will not be effective if

- Water in rice field is not drained off before transplanting
- Snails are not controlled before transplanting

Biological molluscicides

- Tea seed cake: 0.5 gm TSC /L water (100kg/ha)
- Tobacco: leaves, stems or roots?
- *Peltosporum pterocarpum* – leaves
- *Furcrea selloa* & neem extract
- Commercial formulation of biological molluscicides

- Most biological molluscicides are also toxic to fishes and other aquatic organisms.

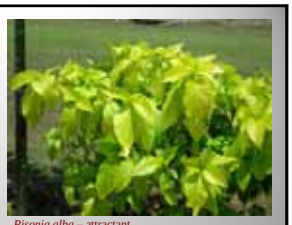
Tea-seed cake

- Active principal: saponin
- Very effective for controlling apple snails.
- Very toxic to all aquatic organisms.
- Rice field should be flooded (2-3 cm deep) before treatment
- Application rate: 50 kg/ha soaked in water overnight before applying into the ricefield
- Never being registered for snail control in Malaysia

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Furcraea selloa



Pisonia alba – attractant





Azadirachta indica (neem) – neem oil, is effective in controlling GAS

Neem extracts

- Field trials using Neemix (Neem oil) showed that it is efficacious on GAS.
- Very expansive

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Habitat modification

- Construct perimeter drains (25cm X 5cm) to concentrate snails after water is drained out.
  - Water is drained off before pre-germinated seeds are broadcasted and before harvesting (at 90 DAP).
    - Facilitate physical removal of snails or spot spraying of molluscicides inside the drain only.
- Construct a drain between two lots of land for irrigation/drainage and facilitate snail management by installing nets or trap at each point of water inlet into the rice field

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Constructing a drain in between two lots of land that will facilitate irrigation or drainage as well as facilitating snail control.

Perimeter drain will facilitate molluscicide application or physical removal of snail by concentrating the snails in the drains when water is drained out of the rice field



Biological control

- Duck pasturing before sowing or transplanting & 35 days after sowing.
- Ducks are driven out of the rice field 80 days after sowing
- Fish farming in the rice fields as well as in the irrigation canals

Advantages of duck pasturing

- Ducks not only feed on snails but also on weeds and weed seeds
- Weedicides use could be avoided
- Environmental friendly
- Increase soil fertility
- Side income to farmers (eggs and sale of ducks)
- Khaki Campbell is the preferred breed of ducks for snail control

- breed

Requirements:

- Dry area
  - Ducks require dry areas for resting, drying and grooming
  - Ducks do not swim far from the dry resting areas
  - Normally, the furthest ducks swim away about 100 m from the resting areas before returning.





Requirements for ducks:

- **Water**
  - For swimming and searching for snails
  - Water depth of between 5 – 10 cm deep is ideal for ducks





Ducks density

- Our studies has shown that at a density of 2 ducks/25 m^2 ,100% control of snails is achieved within 4 days.
- Other studies by the Department of Agriculture, Sabah showed that at density of 5 ducks/ha, 80-90% control could be achieved.
- The more ducks released, the shorter it will take to control the snails.

Chemical control

- Molluscicides: organo-tin, copper sulfate, calcium cyanamide and sodium pentachlorphenolate (Environmental hazard).
- Metaldehyde (14kg/ha)
- Insecticides: isaphophos, cartap dan bensultap.
- Bayluscide (niclosamide ethanolamide) – Specific for controlling aquatic snails: 315g racun/ha at volume of spray of 180L/ha.
- Metaldehyde: rate used 14 kg/ha.
- In Malaysia, only niclosamide and metaldehyde are registered for GAS control

Molluscicides

- Niclosamide
- Metaldehyde
- Triphenyltin acetate (TPTA)
- Fentin Acetate
- Sodium salt of Pentachlorophenol (NaPCP)
- Copper sulfate
- Copper sulfate pentahydrate
- Tea Seed cake
- Neem extracts
- Microbials
- NPK fertilizers

Niclosamide

- One of the registered molluscicides in Malaysia
- Recommended rate used: 315g/ha
- Need to flood the rice field prior to molluscicide application.
- Need to be sprayed evenly in the rice field.
- 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

- Available in granulated and liquid formulations
- Need to be broadcasted/sprayed evenly in the ricefield
- Water level should be reduced to 2-3 cm deep
- Rate used for granulated (5%)- 4.5kg/ha at snail density less than 5/meter square. Higher rates of 14 kg/ha is recommended at snail density of more than 5/meter square.
- After treatment, water need to be retained in the ricefield for 2 – 3 days before being drained off.
- Properly used, can reduced undesirable effects on the environment.



Improper way to apply molluscice



Safety measures should be taken when applying molluscicide

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

What it seems like

- Golden apple snail is not such a big problem.
- Damage observed..almost insignificant
- Farmers could or have managed the problem successfully
- The farmers must have done everything right to obtain such good control of the apple snails.

Use of illegal molluscicides

- Why farmers use them
  - Effective
  - Cheap
- Very rampant lately
- Negative coverage in mass media
- Affect the integrity of the pest management community
- Side effects to farmers
- Safety and environmental issues

Fentin Acetate

ORGANOTIN COMPOUNDS

These compounds are formulated as wettable and flowable powders for use mainly as fungicides to control blights on field crops and orchard trees. Fentin chloride was also prepared as an emulsifiable concentrate for use as a molluscicide (Aquatin 20 EC, discontinued 1995). Tributyltin salts are used as fungicides and antifouling agents on ships. They are somewhat more toxic by the oral route than triphenyltin, but toxic actions are otherwise probably similar.

Recognition and Management of Pesticide Poisonings, 5th edition, U.S. EPA, Chapter 15, page 150

Fentin Acetate

Toxicology

These agents are irritating to the eyes, respiratory tract, and skin. They are probably absorbed to a limited extent by the skin and gastrointestinal tract. Manifestations of toxicity are due principally to effects on the central nervous system: headache, nausea, vomiting, dizziness, and sometimes convulsions and loss of consciousness. Photophobia and mental disturbances occur. Epigastric pain is reported, even in poisoning caused by inhalation. Elevation of blood sugar, sufficient to cause glycosuria, has occurred in some cases. The phenyltin fungicides are less toxic than ethyltin compounds, which have caused cerebral edema, neurologic damage, and death in severely poisoned individuals who were exposed dermally to a medicinal compound of this type.[23] No deaths and very few poisonings have been reported as a result of occupational exposures to phenyltin compounds.

Recognition and Management of Pesticide Poisonings, 5th edition, U.S. EPA, Chapter 15, page 150

Fentin Acetate

(Table 1, cont.)

Chemical/chemical class	Examples of pesticides	Clinical presentation	Route of exposure[a]
Organophosphates (insecticides)	Malathion, parathion, dichlorvos, chlorpyrifos	Headache, dizziness, bradycardia, weakness, anxiety, excessive sweating, fasciculations, vomiting, diarrhoea, abdominal cramps, dyspnea, miosis, paralysis, salivation, tearing, ataxia, pulmonary oedema, confusion, acetylcholinesterase inhibition	O, D
Organotin (fungicide)	Fentin acetate, fentin chloride	Airway, skin, and mucous membrane irritation, dermatitis, salivation, delirium, headache, vomiting, dizziness	O, R, D
Phenol derivatives (Fungicide, wood preservative)	Pentachlorophenol, dinitrophenol	Skin, airway, and mucous membrane irritation, contact dermatitis, dyspnea, diaphoresis, urticaria, tachycardia, headache, abdominal pain, fever, tremor	O, R, D
Pyrethrins, Pyrethroids	Allethrin, cyfluthrin, permethrin	Allergic reactions, anaphylaxis, dermatitis, paresthesias, wheezing, seizures, coma, pulmonary oedema, diarrhoea, abdominal pain	R, D

http://www.who.int/bulletin/volumes/86/3/07-041814.pdf

Fentin acetate

SCHEDULE 1 POISONS

A	Aldicarb Aluminium phosphide Arsenic and its compounds	N	Nicotine and its salts
B	Barium salts (except barium sulfate) Bromomethane	O	Oxamyl
C	Carbofuran Chloropicrin Cycloheximide	P	Paraquat and its salts Phosphorus compounds – the following: Azinphos-methyl Chlorfenvinphos Demephion Demeton-S-methyl Demeton-S-methyl sulfone Dialifos Dichlorvos Dioxathion Disulfoton Fonofos Mecarbam Mephosfolan Methidathion Mevinphos Phorate Phosphamidon
D	Dinitrocresols and metal derivatives Dinoseb and metal derivatives Dinoterb Drazoxolon and its salts		
E	Endosulfan Endothal and its salts Endrin Fentin and its compounds Fluoroacetic acid and its salts; fluoroacetamide		

PCP

Data are scarce on the toxicity of PCP to mammalian wildlife, but studies with livestock and small laboratory animals show that the chemical is rapidly excreted. However, there is great variability between species in their ability to depurate PCP, as well as in their overall sensitivity. Acute oral LD-50's in laboratory animals were 27 to 300 mg/kg BW. Tissue residues were elevated at dietary levels as low as 0.05 mg/kg feed and at air levels >0.l mg/m^3. Histopathology, reproductive impairment, and retarded growth were evident at doses of 0.2 to 1.25 mg/kg BW, and when the diets fed contained >30 mg PCP/kg.

In soils, PCP persisted for 15 to more than 60 days, depending on soil conditions and application rate. At initial concentrations of 100 mg PCP/kg soil, the Tb 1/2 was 10 to 40 days at 30°C under flooded conditions; however, in aerobic soils there was virtually no degradation after 2 months (Kaufman 1978). In rice paddy soils, initial concentrations of 4 mg PCP/kg fell to 2 mg/kg in 7 days (Bevenue and Beckman 1967). Pentachlorophenol was still measurable after 12 months in warm, moist soils (Cote 1972; EPA 1980). In estuarine sediments, degradation was most rapid under conditions of increased oxygen and a pH of 8.0 (DeLaune et al. 1983).

Main concerns on use of Na-PCP and Fentin acetate

- Both products are not registered for use as molluscicide
- Labels and application instructions not understood by farmers
- They are available only through black market
- Reportedly very effective in controlling GAS
- One or both products are widely used in MADA, Felcra Seberang Perak and Sekinchan.
- Where do we stand on these 2 products?

Copper sulfate

Acute toxicity: The oral LD50 of copper is 472 mg/kg in rats. Copper sulfate is caustic and acute toxicity is largely due to this property. The lowest dose of copper sulfate that has been toxic when ingested by humans is 11 mg/kg. Ingestion of copper sulfate is often not toxic because vomiting is automatically triggered by its irritating effect on the gastrointestinal tract. Symptoms are severe, however, if copper sulfate is retained in the stomach, as in the unconscious victim. Some of the signs of poisoning which occurred after 1 to 12 g of copper sulfate was swallowed. Copper sulfate can be corrosive to the skin and eyes. It is readily absorbed through the skin and can produce a burning pain, as well as the other symptoms of poisoning resulting from ingestion. Examination of copper sulfate-poisoned animals showed signs of acute toxicity in the spleen, liver, and kidneys. Injury may also occur to the brain, liver, kidneys, and gastrointestinal tract in response to overexposure to this material. Some of the signs of poisoning that occurred after 1-12 g of copper sulfate was swallowed include: a metallic taste in the mouth, burning pain in the chest and abdomen, intense nausea, repeated vomiting, diarrhea, headache, sweating, shock, and discontinued urination leading to yellowing of the skin. Injury to the brain, liver, kidneys, stomach, and intestinal linings may also occur in copper sulfate poisoning. It is readily absorbed through the skin and will give the above symptoms. Contact with skin causes burns and also acts as a sensitizer. Later exposure can cause allergic reactions (Kamrin 1997; Extoxnet).

Copper sulfate – chronic tox

Chronic toxicity: Vineyard sprayers experienced liver disease after 3 to 15 years of exposure to copper sulfate solution in Bordeaux mixture. Long-term effects are more likely in individuals with Wilson's disease, a condition that causes excessive absorption and storage of copper. Chronic exposure to low levels of copper can lead to anemia. The growth of rats was retarded when given dietary doses of 25 mg/kg/day of copper sulfate. Dietary doses of 200 mg/kg/day caused starvation and death. Sheep given oral doses of 20 mg/kg/day showed blood cell and kidney damage. They also showed an absence of appetite, anemia, and degenerative changes.

Reproductive effects: Copper sulfate has been shown to cause reproductive effects in test animals. Reproduction and fertility was affected in pregnant rats given this material on day 3 of pregnancy.

Teratogenic effects: There is very limited evidence about the teratogenic effects of copper sulfate; unlikely to be teratogenic in humans at expected exposure levels.

Mutagenic effects: Copper sulfate may cause mutagenic effects at high doses. At 400 and 1000 ppm, copper sulfate caused mutations in two types of microorganisms. Such effects are not expected in humans under normal conditions.

Copper sulfate - Env. effects

Copper is a heavy metal that has a potential to build up in soil and decrease the productivity and filter and buffer capacity (Andreu, 1999). This may be more of a concern in fragile ecosystems such as marsh or wetlands than rice crops. When heavy metals enter the soil they may: (a) remain in soil solution and run off in drainage water, (b) be taken up by plants, or (c) be retained by soil in soluble or insoluble forms. In a system that is seasonally wet and dry, there is continuous change in the availability of metals due to cycles of aerobic and anaerobic conditions affecting the soil redox potential. This may make such soils more vulnerable to enhanced solubility and toxicity of metals (Andreu, 1999). Of the metals, copper is relatively more mobile (extractable) than cadmium, lead, zinc, nickel, or cobalt, but even so is retained in the soil for a very long time periods. In a study that sampled the same site over a five-year period in a rice growing region of Spain, it was found that copper does, however, gradually decrease over time, unlike cadmium that has shown a tendency to increase (Andreu, 1999). Copper is found in the upper levels of the soil profile, and decreases with depth.

Copper sulfate pentahydrate

(4) The effect of the substance on human health;

The reviewer covered most of this under [criterion] 2. One thing left out is that there is an excess of cancer cases in the copper smelting industry (Sax 1979). Of significance is the tendency to bioaccumulation, the problem with skin absorption, and the liver damage of vineyard workers after 3-15 years exposure. Chronic exposures to animals caused problems at 20mg/kg/day (Kamrin 1997).

Copper sulfate pentahydrate applied at 15 lb/acre of rice led to accumulation of 3.5 to 5.7 mg/kg in rice seed. Daily copper consumption of treated rice for one person should be no greater than 6 mg (Dunnigan and Hill 1978). Daily copper intake from rice in China is reported to be 1.4 mg/person (Herawati et al. 1998). Exposures of 1.3 mg/liter are permitted in drinking water (EPA 2001).

Use of copper sulfate on rice at 10lbs/acre does not seem to pose a human health risk from ingested food.

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Why snails failed to be controlled effectively

- Snail entry from irrigation/drainage systems and waterways
  - Fail to put up strainers/traps
  - Overflow from irrigation/drainage system
  - Improper drain – not managed properly
- Water level in the ricefield could not be managed accordingly
- Flood

FACTORS CONTRIBUTING TO FAILURE TO CONTROL THE APPLE SNAILS

- **Bund not properly maintain – broken bunds allowing snails from the irrigation/drainage canals to enter the rice field.**
- **Overflow of irrigation canal during high tides or after heavy rains.**
- **Flooding**







Constraints in GAS Management

- Taxonomic confusion of *Pomacea spp.* complex.
- Timely community actions are rarely practiced to reduce GAS build-up. Thus there is a need to demonstrate the integrated approach to GAS management – Pilot projects
- Lack of viable technologies to manage GAS in flood-proned areas
- Lack of chemicals to control the egg masses
- Very few information on the effect of botanical molluscicides on non-target organisms.
- Choice of non-specific pesticides still preferred by farmers because of immediate kill, ease of application, cost and efficacy.

Conclusions

- Management of GAS requires an integrated and concerted approaches
- Failure to obtain effective control partly due to attitude of farmers who failed to practice proper snail management procedures.
- Use of illegal molluscicides need to be curbed accordingly
- Movement of contaminated machineries, human intervention and natural disaster such as flood contributes to the spread and dispersal of the snail