GLOBE Thailand Activities Report 2016

The Institute for the Promotion of Teaching Science and Technology (IPST)
Ministry of Education
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GLOBE THAILAND REPORT
October 2015 – July 2016

1. GLOBE STEM Train-the-Trainer workshop

IPST and Mae Fah Luang University arranged GLOBE STEM Train-the-Trainer workshop on 18 – 23 January 2016 at Mae Fah Luang University, Chiang Rai province. There were 88 participants from Thailand, Taiwan, USA, Vietnam and Sri Lanka. The workshop were Basic and Advance GLOBE Protocol training: Soil, Land Cover, Atmosphere, Hydrology and Mosquito. In addition, there were the SMAP Training from Mr. Peter C. Falcon, Earth Science Outreach Coordinator from Jet Propulsion Laboratory, NASA, USA and Dinner Talk “GPM Mission for Research and Education” by Miss Dorian W Janney, Formal Education Specialist for Global Precipitation Measurement, NASA, USA.

In this workshop, Intel Micro Electronic (Thailand) Ltd. supported material and equipment for Pre-workshop GLOBE STEM with Intel IoT. The participant learn about using sensor technology with Intel Galileo and Intel Edison to collect environment data from the instructors, Assoc.Prof.Dr.Krisanadej Jaroensutasinee and Assoc.Prof.Dr. Mullica Jaroensutasinee walailak Univerrsity.
2. Environmental Science Research Competition

2.1 Thailand GLOBE Student Research Competition 2016

Thailand GLOBE Student Research Competition 2016 was open to primary and secondary school students during 30 March - 1 April 2016. There were Oral presentation 20 researches and Poster Presentation 44 researches. The winners are as follows:

Primary school category:
First prize: Dara Academy, Chiang Mai Province, Effects of Environmental Factors and Vessels on the Number of Mosquito Larvae
Second prize (2 awards): Anuban Lampang (Khelangrat-Anusorn) School, Lampang Province, Relationship between Weather and Quantity and Types of Mosquitos and Feasibility of Using Sound Wave to Destroy Mosquito Larvae in Residential and Khelangratna School Areas
Second prize: St. Joseph Thiphawan School, Pencil Shavings Tinder

Lower Secondary school category:
First prize: Donchanwitthayakhom school, Kalasin province, Growing Chainat 1 Rice: Drought Endurance and Use of Local Materials to Absorb Moisture in Soil
Second prize: Bangkok Christian College, Bangkok, BCC Nitro Product and Application in Place of Chemical Fertilizers
Third prize: Chum Phae Suksa School, Khon Kaen province, Effects of Temperature and Relative Humidity on the Growth of Phoenix Oyster Mushroom
Consolation prize: Suratpittaya school, Surat Thani province, Bioactive Plastic from copolymer Mucilage
Consolation prize: Silacharaphiphat School, Bangkok, Results of Use of fermented water Hyacinth juice to Improve Urban Soil pH for Planting

Higher Secondary school category:
Second prize: Sa-Nguan Ying School, Suphan Buri province, Effect of Laurel Clockvine Leafs on Residual Substances in Soil
Third prize: Donchanwitthayakhom school, Kalasin province, Making Fuel Bar from Coconut Husk
The Poster Presentation category:
The Best Poster Presentation prize was awarded to Princess Chulabhorn’s college Pathumthani for the presentation of its research project titled “Synthesization of Zeolite from Rice Stubbles in Elimination of Zinc from Wastewater”

The Best Popular Vote Poster Presentation was awarded to Hankha Pittayakhom School for the presentation of its research project titled “Wastewater Treatment Plants”

The Best STEM Poster Presentation was awarded to Bangkok Christian College for the presentation of its research project titled “BCC Nitro Product and Application in Place of Chemical Fertilizers”
2.2 Thailand Junior Water Prize 2016
IPST has signed agreement of cooperation with Stockholm International Water Institute (SIWI) on 25 December 2015 to send the winner team in Thailand to Stockholm Junior Water Prize 2016-2018. IPST organized the Thailand Junior Water Prize 2016 competition on 24 May 2016 with an objective to encourage students to learn about, care for, and conserve water resources. Students were invited to submit their innovative water conservation methods to the competition. The winner was the research Titled “Natural Innovative Water Retention Mimicry Bromeliad (Aechmea aculeatosepala)” from Suratpittaya school, Surat Thani province.

In this year, IPST received the partial grant by Nestlé (Thai) Ltd. and Government Savings Bank.
3. Cooperation with Universities in Promoting Environmental Science Research Based on STEM Education Concept

IPST cooperates with universities in the GLOBE network to systematically multiply the results of environmental education so as to build GLOBE Thailand’s cooperative academic network at both national and international level as well as to develop students’ knowledge and competence in undertaking environmental science research within the context of STEM education. In this fiscal year 2016 (1 October 2015 - 30 September 2016), IPST provided operational budget for this purpose to Thaksin University, Walailak University, Prince of Songkla University Surat Thani Campus, Suratthani Rajabhat University, Loei Rajabhat University, Burapha University, Srinakharinwirot University, Kasetsart University Kamphaengsaen Campus, Sirindhorn International Institute of Technology of Thammasat University Mahidol University, and Mae Fah Luang University. In all, 100 schools took part in different activities organized by the universities as follows:

1. Thaksin University

TSU STEM Education Teacher Training: 11th training workshop for teachers in Pattalung Province was conducted on 9 – 11 September 2015. Seven lecturers from TSU attended the GLOBE STEM Train-the-Trainer Workshop 2016 for increasing the number of GLOBE trainers. The GLOBE website for Thaksin University was developed.
2. Walailak University

The two projects undertaken this year are 1) Pilot Research Project on 30 June 2016 using “Use μEye with mosquitos GLOBE Protocol”, and 2) Global Precipitation Measurement (GPM) and GLOBE Data and Information System which is ongoing.

3. Prince of Songkla University, Surat Thani Campus

During this reporting period, PSU, Surat Thani Campus will develop the tropical pitcher plants protocol which includes lesson plan. The five schools that took part in this project undertook five research works.
4. **Suratthani Rajabhat University**

SRU was conducted the project which aim at supporting potential of GLOBE Alumni Thailand. Former GLOBE students were provided with necessary support to enable them to assist teachers and students concerned. Open communication among them through chat group is encouraged. Activities in each region were also publicized and updates provided through online channel.

5. **Loei Rajabhat University**

A training workshop on environmental data verification was conducted on 8-9 May 2016 at Loei Rajabhat University. Collection of data on Soil, Hydrology, Atmosphere and Land Cover is under way.

6. **Burapha University**

A collaborative environmental research development project was undertaken involving scientists and teachers and students from five schools.
7. Srinakharinwirot University
On 10 February 2016, a training workshop on assembling and installing SWU-GE1 was conducted with a view to applying Intel Galileo Board GEN2 firstly to the development of a weather station, and secondly to designing, assembling and installing SWU-GE1 station.

8. Kasetsart University Kamphaeng Saen Campus
The Kamphaeng Saen Campus of Kasetsart University implemented a soil science research development project based on joint collaboration between scientists and teachers and students. Under this project, research grants were awarded to five schools to undertake one soil science research each. It was required that each research apply STEM education concept. In this connection, a workshop was organized on 18-19 May 2016 to develop soil science education research proposals within the context of STEM education. The research projects are ongoing.
9. Mahidol University
In an attempt to establish linkage between air pollution in Bangkok Metropolitan and its perimeter and other daily life factors, two training activities were organized on 28 May and 9 July 2016 to focus on measuring weather conditions and cloud observation as well as GLOBE data entry. Eight schools participated in this project.

10. Mae Fah Luang University
Five schools in Chiang Rai Province participated in a comparative study project focusing on growth of corn in different environments. Data collection is still ongoing.

11. Sirindhorn International Institute of Technology
Under the project for the promotion of environmental learning through application of micro-controller, students from six schools in Lampoon Province attended a training on 28 May 2016. The project is in its data collection phase.
4. Climate Change Supplementary Materials Development

IPST had received partial grant from US Embassy and cooperate with Laos to implement the climate change supplementary into school. IPST had developed climate change supplementary for upper primary level (Grade 4-6) and Lower secondary level (Grade 7-9). These activities aim at giving the students practical experience in Climate Change education such as Weather and Climate, Impact, Mitigation and Adaptation of Climate Change. To increase students' awareness of sustained natural resource and environmental conservation, the learning activities have been designed to motivate them to continue their exploration, investigation and search for knowledge.

IPST arranged the Meeting on the development plan for climate change supplementary in 22 – 23 March 2016 at Amari boulevard Hotel, Bangkok. These activities were tried out in primary and lower secondary schools in Laos 8 – 10 June 2016 and Thailand in July – August 2016.
5. Promotion of Environmental Science Research in SMAP Project

The Soil Moisture Active Passive (SMAP) Project measures soil moisture from space. IPST arranged GLOBE SMAP/CloudSat Workshop on 28 January 2016 at IPST. The instructor was Mr. Peter C. Falcon, Earth Science Outreach Coordinator from Jet Propulsion Laboratory, NASA, USA. There were 41 teachers and educators from 19 schools joined this workshop. They learned Soil Moisture protocols, Cloud Protocol, measurement and GLOBE data entry. The students can become engaged with a NASA mission and learn how satellite information can improve knowledge of Earth.
6. Student Exchange Program

6.1 Thailand – India – Taiwan Student Exchange Program 2016
Twenty two students, teachers and scientists from Donchanwitthayakhom school, Phukradungwittaykom school, Plutaluangwittaya school, Thatumprachasermwit school, Phichai Rattanakhan school and Singburi school took part in the Thailand – India – Taiwan Student Exchange Program 2016 on 15 – 19 December 2015 at Bhubaneswar, India. The participants with opportunities to share and exchange experiences via presentation of their research.

6.2 STEP-NUS Sunburst Environment Programme 2015
STEP-NUS Sunburst Environment Programme 2015 took place in RELC International Hotel, Singapore during 22 - 28 November 2015. Five participants namely, Peyachad Dhanawuthivorn (Surasak Montree School, Bangkok), Narisorn Juprachakorn (Yupparaj Wittayalai School, Chiang Mai), Sasiporn Indam (Phichairattanakhan School, Ranong) and Tanawat Jantra (Chakkham Khanathon School, Lamphun) and Ms. Chalita Thanyakoop from IPST attended this Programme. The students presented their research project “Climate Change and the Food Security of Thailand” in oral and poster presentation sessions.
7. The GLOBE Asia-Pacific Regional Meeting 2016

GLOBE Regional Coordination Office Asia – Pacific Region and GLOBE Thailand IPST organized the GLOBE Asia-Pacific Regional Meeting 2016 at Disit Island Resort, Chiang Rai province, Thailand from 14 – 16 January 2016. The GLOBE partner in Asia – Pacific Region presented their activities and updated new information from the GLOBE Implementation Office.
8. GLOBE Annual Partner Meeting 2016

The GLOBE Annual Partner Meeting 2016 will be held in Estes Park, Colorado, USA during 16 - 21 July 2016. There are 2 representatives from GLOBE Thailand, IPST, participating in this meeting.

9. GLOBE-STEM Workshop

IPST arranged the GLOBE protocol workshop and design instrument (convex mirror and rain gauge) on 26 – 28 November 2015 at Uthaiwitthayakhom school.
10. A day in a life of the NASA

Geo-Informatics and Space Technology Development Agency (Public Organization) (GISDA), US Embassy and IPST arranged special talk by Dr. Juan A. Roman “A Day in the life of the NASA engineer” on 24 February 2016 at Space Inspirium, Chonburi province. He has inspired the students to focus on space engineer. Hopefully, Thai youth will appreciate the importance of space technology which will contribute to further growth of Thailand. There were 109 participants from 30 schools attending this event.
Student Research 2016
The study of properties of soil under different rice field postharvest management

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Abstract

Three methods of postharvest management in rice fields including burning the remaining rice straws in fields (method 1), flooding the fields before plowing the soil (method 2), and planting mung beans before plowing the soil (method 3) were studied. Different methods affected soil chemistry at different degrees. The study of soil chemistry under the applications of these methods was carried at rice fields in Tambon Jak-sri, Singburi Province. The results showed that the use of method 1 resulting in basic soil compared to the other methods. The application of method 3 resulted in higher nutrient contents (nitrogen, phosphorus, and potassium) in the soil than the other methods. Therefore, the best rice field postharvest management was method 3.

Keywords: postharvest management, soil chemistry, rice field, Chainat Soil Type

Introduction

Farmers usually prepare their rice fields using different methods after harvest as a preparation for the next rice cultivation (Rice Cultivation, 2556 B.E.). The most popular methods include burning the remaining rice straws in fields (method 1), flooding the fields before plowing the soil (method 2), and planting mung beans before plowing the soil (method 3) (Figure 1). In method 1 the straws are air drying and burning. After that, farmers plow the top soil before the next rice cultivation. In method 2 large amount of water is used to flood the fields for 7 days. The remaining rice straws are left in the flooded field. The decomposed plant matters are mixed with the top soil before the next rice cultivation. The last method has become popular recently. Farmers remove some of the remaining rice straws from the fields. Then,
they plant mung bean seeds in the fields. The mung beans are harvested for sale. Then, the top soil is plowed and mixed with plant matters before the next cultivation. These methods were also employed by farmers in Tambon Jak-sri, Muang District, Singburi Province. Different methods affected soil chemistry in different degrees depending on many factors including the soil types. The soil in Tambon Jak-sri was classified as the Chainat Soil Type (Land Development Department, 2554 B.E.). It was important to study the effect of rice field preparation methods on soil chemistry.

Figure 1. Three different rice field postharvest management methods.

Objectives

1. To study soil chemistry in rice fields under three management methods.
2. To evaluate these methods in order to make recommendation for farmers.

Research Questions

How did these methods affect soil chemistry?

Hypotheses

All activities performed in these methods likely influenced soil chemistry.
If method 1 is used the the soil chemistry will be poor because burning process will destroy the soil.
If method 2 is used the the soil chemistry will be poor because flooding process will destroy the soil.
If method 3 is used the the soil chemistry will be good because mung bean will improve the soil quality.
Variables

Independent variables: different methods for rice field preparation before the next rice cultivation (method 1, 2, and 3)
Dependent variables: soil chemistry (pH, nitrogen (N) content, phosphorus (P) content, and potassium (K) content)
Control variables: Chainat Soil Type, time of soil sampling

Materials and Methods

- Soil sample collection
  Samples were collected once a month from November 2013 to January 2014. The sampling site covered approximately 1,600 m². Fifteen samples were collected at a time as shown in Figure 2. Top soil (15 cm from soil surface) was removed and stored in plastic bags. Then, all samples collected in one month were mixed, air dried, and divided into four portions (Department of Soil Science, Kasetsart University, 2556 B.E.).

- Soil chemistry analyses
  Soil pH, N, P, and K contents were examined following GLOBE protocol (IPST, 2556 B.E.). The experiments were performed using the soil test kit developed by Kasetsart University, Kamphangsan Campus.

Results

Soil chemistry was different for the three postharvest management methods (Table 1). The highest average soil pH was found under the use of method 1. Soil nutrient contents were highest when method 3 was applied.
Table 1. Soil chemistry under the application of three postharvest management methods.

<table>
<thead>
<tr>
<th>Postharvest management method</th>
<th>Average soil pH</th>
<th>Average soil Nitrogen</th>
<th>Average soil Phosphorus</th>
<th>Average soil Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method 1</td>
<td>7.2</td>
<td>Very low</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>Method 2</td>
<td>6.3</td>
<td>Medium</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>Method 3</td>
<td>6.5</td>
<td>Very high</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Discussion and Conclusions

Different postharvest management methods affected soil chemistry differently. Soil pH was slightly acidic under the use of method 2 and 3. The burning of rice straws reduced the organic matters in the soil. The decomposition of rice straws left in the fields under the use of method 2 and 3 increased the organic matter, which reduced soil pH. Slightly acidic soil is appropriate for rice cultivation. More basic soil may require the addition of chemicals to reduce soil pH.

Overall nutrient contents were high when method 3 was applied, especially nitrogen content. It was not surprising since mung bean roots show the symbiosis with the bacteria *Rhizobium* that could capture atmospheric nitrogen into the soil (Atthanane and Veerapattananiran, 2554 B.E.). The mixture of rice straws with the top soil could slightly increase soil potassium because rice straws contained 1.72% potassium while other nutrients were very low.

Therefore, the application of method 3 was a better land preparation for the next rice cultivation than the other methods. Higher soil nutrient contents than other methods could reduce the use of fertilizers for rice cultivation. Furthermore, the harvest of mung beans could provide additional income after rice harvest.

Acknowledgements

We would like to thank our advisor and science teachers for their advice, The Institute for the Promotion of Teaching Science and Technology (IPST) and The GLOBE Program for funding of the project, the Department of Soil Science—Kasetsart University for advice, Ms. S Prasartponchai and Ms. Fiona Gibb for writing advice, our friends and families for their encouragement.


References


The relationship between sediment and diversity of Fiddler crabs (*Uca* spp.) at the Andaman Coastal Development Research Station, Kasetsart University

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Advisor: Mr. Supamon Inchan

Abstract

Fiddler crabs are benthic macroinvertebrates commonly found in mangrove forests. The distribution of these invertebrates may be related to some physical and chemical characteristics of the sediment in the forests. The comparison of sediment characteristics at three different stations showed that soft clay was associated with the presence of crabs with large pincers. Stations with fine sediment (125 µm) and a lot of organic matters were occupied by *Uca annulipes* and *U. urvillei*. Coarse sediment (500 µm) was found at the station at the mouth of the river where highest diversity of Fiddler crabs (*U. annulipes, U. vocans, U. urvillei,* and *U. dussumieri*) was observed. This information could be useful for the conservation of mangrove forests in the future.

Keywords: Fiddler crab, sediment, organic matter, mangrove forest

Introduction

Fiddler crabs (*Uca* spp.) inhabit the intertidal zones tropical and temperate regions (Crane, 1975). They influence the ecosystems by changing physical characteristics of the sediment called bioturbation (Costa et al., 2006). The presence of Fiddler crabs is used as bio-indicators of mangrove forests (Pahurat, 2526 B.E.). Previous studies revealed the relationship between soil salinity and sediment particles influenced diversity and abundance of benthic macroinvertebrates in the inner Gulf of Thailand (Srisuchart, 2524 B.E.) and the upper coastal area of the Andaman Sea (Sawangareerak and Mokarat, 2540 B.E.). Nevertheless, fine scale investigation of the relationship between sediment size and diversity and abundance of Fiddler crabs requires detail.
Objectives

1. To examine the physical and chemical characteristics of sediment at Prapas Beach at the Andaman Coastal Development Research Station, Kasetsart University.
2. To study the diversity and distribution of Fiddler crabs at different sediment characteristics.

Research Questions

1. Were sediment characteristics related to the presence of organic matters?
2. Were sediment characteristics related to the density of Fiddler crabs?
3. Were sediment characteristics related to the diversity of Fiddler crabs?

Hypotheses

Because physical and chemical characteristics of sediment influenced the distribution of benthic macroinvertebrates, the density and diversity of Fiddler crabs would also be different.

Materials and Methods

1. Sampling sites included three stations at the Andaman Coastal Development Research Station, Kasetsart University. The coordinates of these sites were recorded using GPS. The 1st station or ST1 (N 09°22.583', E 098°23.930') was the inland zone where water fluctuated. The 2nd station or ST2 (N 09°22.705', E 098°24.017') was the middle or flooded zone where water was present at all time. The 3rd station or ST3 (N 09°22.762', E 098°24.102') station was the coastal zone near Kam Puan Creek.
2. Fiddler crab sampling was conducted using a 0.5 x 0.5 m² quadrat. The number of crab holes was counted for density estimate. Five replicates were completed by placing the quadrat 2 m apart. In addition, the size of the holes were also measured and recorded. Fiddler crabs collected in the quadrats were brought to the laboratory for species identification.
3. Soil samples were collected using a pipe with 15 cm diameter and 10 cm long.
4. Species of plants and other organisms at the sampling stations were photographs and recorded.
5. Fiddler crabs were brought to the laboratory and cleaned with water before kept frozen for further identification.

6. The density of Fiddler crabs was calculated using the formula:
   Density = the number of Fiddler crabs’ holes/ sampling area size

7. The volume of soil samples was determined. Soil samples were separated for particle size determination and chemical analyses. Particle size of the soil was determined using sieves of 1 mm, 500 μm, 250 μm, 125 μm, and 63 μm. Wet weight of each size class was measured.

8. The soil samples were dried at 105°C for 4 hours in an oven. Dry weight of the samples was measured and calculated for the percent soil composition.

9. Other soil characteristics including texture, color, and organic matters containing in the soil were observed and recorded.

10. The pH, salinity, the percent organic and inorganic (ammonia—NH₃, nitrate—NO₃⁻, potassium—K, and phosphorus—P) compositions of the soil were analyzed.

Results

Soil with the particle size less than 250 μm was found the most at ST1 and ST2 (Figure 1). At ST3, soil with the particle size between 125-500 μm was found the most indicated the high composition of sand. Mixture of plant matter and high organic composition were found in soil samples from ST1 and ST2 (Table 1). This was associated with the presence of many mangrove species, such as Avicennia alba, Rhizophora apiculata, Thespesia populnea, and Hibicus tilliaceus. Ammonia content was high at ST3. The nitrate content was virtually rare at all 3 stations. Potassium content was high at ST1, while phosphorus was low at this station and high in the other stations. Soil from ST1 was quite acidic with the pH of 5 whiles samples from the other stations were slightly basic. The highest salinity was observed at ST2 while the lowest salinity was recorded at ST3.

Fiddler crabs collected in this study varied in size and density (Table 2). Uca annulipes was present at all sampling stations. The small U. urvilllei was found at ST2 and ST3. The additional two species (U. vocans and U. dussumieri) were found at ST3.
Figure 1. The percent of different soil particle sizes at sampling stations.

Figure 2. The particle size distribution of soil from three different sampling stations.
Table 1. The physical and chemical characteristics of soil at the sampling stations.

<table>
<thead>
<tr>
<th>Sampling station</th>
<th>Soil texture and color</th>
<th>Amount of inorganic compounds</th>
<th>Percent organic matter</th>
<th>Soil pH</th>
<th>Soil salinity (ppt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1</td>
<td>Red-brown, with the mixture of roots and plant matter</td>
<td>Low</td>
<td>High</td>
<td>2.05</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td>Low</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>ST2</td>
<td>Clayey, brown, with the mixture of roots and plant matter</td>
<td>Medium</td>
<td>Medium</td>
<td>1.55</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td>Medium</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>ST3</td>
<td>Sandy, yellowish brown</td>
<td>High</td>
<td>Very low</td>
<td>0.23</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>High</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Fiddler crabs species identification and density estimation.

<table>
<thead>
<tr>
<th>Sampling station</th>
<th>Species of Fiddler crabs</th>
<th>Sizes of Fiddler crabs</th>
<th>Density of Fiddler crab</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1</td>
<td>U. annulipes</td>
<td>Varied</td>
<td>23.2</td>
</tr>
<tr>
<td></td>
<td>U. urvilllei</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>U. vocans</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>U. dussumieri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST2</td>
<td>U. annulipes</td>
<td>Varied</td>
<td>64.8</td>
</tr>
<tr>
<td></td>
<td>U. urvilllei</td>
<td>Small</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U. vocans</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>U. dussumieri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST3</td>
<td>U. annulipes</td>
<td>Varied</td>
<td>60.8</td>
</tr>
<tr>
<td></td>
<td>U. urvilllei</td>
<td>Large</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U. vocans</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>U. dussumieri</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion

The presence of Fiddler crabs appeared to be related with soil particle size. Four species of Fiddler crabs with high density were found at ST3, which contained soil of particle size between 250-500 µm. *Uca annulipes* was presented at all stations and various sizes were found in ST1. Low density of Fiddler crabs was observed at ST1 because this station was closest to human community. ST2 was an inundated area, and soil particles were very small. Small species of Fiddler crabs were found at this station. The Highest density of Fiddler crabs was observed at this station probably because this was the nursing area for aquatic animals. ST3 was a
sand bar with the highest sediment accumulation and located farthest from human community. Soil particles at this station were larger than those at the other stations. Large species of Fiddler crabs and large individuals of small species were present at this station. Different zones of mangrove forests provided different habitats for various species of crabs. The maintenance of the zones influences the diversity and abundance of Fiddler crabs, which are important natural resources of the community.

**Acknowledgements**

The authors would like to thank our advisor and co-advisor for their advice and help with the equipment and sampling. We thanked our friends, families, The Institute for the Promotion of Teaching Science and Technology (IPST) and The GLOBE Program for their support and encouragement.

**References**


The relationship between physical characteristics of sea water and the jellyfish bloom in Sattahip Gulf, Chonburi Province

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Grade: 9th
Advisor: Mrs. Sukanya Suwaree

Abstract

Jellyfish bloom is a natural phenomenon that occurs when many jellyfish gather in an area as a result of increasing food sources, changing tides, and discharging of freshwater into the sea. However, the abnormal blooms have been reported for several years. They might be corresponded with some physical characteristics of sea water. Four selected sites in the Sattahip Gulf were assigned to study in this work. The characteristics of sea water were recorded in September 2014 before the jellyfish bloom occurred to compare with those during the bloom in October 2015 and after the bloom between November and December 2015. The 2013 data retrieved from the Hydrographic Department of the Royal Thai Navy were also used as a reference. The result showed that the jellyfish bloom could be related with the increase in sea water temperature, as a consequence of climate change.

Keywords: jellyfish bloom, sea water, climate change, Sattahip Gulf

Introduction

Jellyfish are invertebrates classified in the phylum Cnidaria. They are short-lived but important for the marine ecosystem. The abundance of jellyfish mainly depends on the abundance of food. When many of them gather together in one area, it is called jellyfish bloom, which is considered a natural phenomenon. This bloom is caused by many factors, such as the increase in freshwater discharge and tidal change. Nevertheless, in the last 10 years, the jellyfish bloom has become unusual because it happened more frequently. High sea water temperature recorded in previous years was associated with the early bloom during August and September rather than in October. This unusual bloom has affected the fisheries and tourism business and required information for future management. Other characteristics in addition to temperature could contribute to the occurrence of this phenomenon,
which remained to be investigated. Therefore, this study aimed to examine the following physical characteristics of sea water; pH, salinity, and temperature.

**Research Questions**

How does these physical characteristics of sea water affect the jellyfish bloom?

**Hypothesis**

Based on previous information, physical characteristics were related with the jellyfish bloom.

If the sea water temperature increase, the jellyfish bloom occurs.

If the sea water pH increase, the jellyfish bloom occurs.

If the sea water salinity decrease, the jellyfish bloom occurs.

**Materials and Methods**

- **Study sites**

  Four sites in Sattahip Gulf were assigned (Figure 1). Site 1 was located at Prapakarn Beach (Lat 9.7° N/ Long 47.1°E). Site 2 was in the Samaesarn Villa (Lat 8.3° N/ Long 5.4° E). Site 3 was at Phra Maha Jetsadaratchao Camp (Lat 47.7° N/ Long 48.1°E). Site 4 was at the Naval Sea Turtle Conservation Center (Lat 9.7°N/ Long 34.2°E).

![Map of the four selected study sites in Sattahip Gulf, Chonburi, Thailand.](image)

- **Monitoring of physical characteristics of sea water**

  Data collections were performed in September, October, November, and December 2015. The measurements were performed once a month started from Site at 8 am followed by site 2 at 8.20 am, site 3 at 8.40 am, and site 4 at 9.20 am. All measurements were conducted at 30 centimeters deep below the sea surface.
and 100 meters distance from the coast. Sea water temperature was measured by a handheld thermometer. pH and salinity of sea water were measured using a pH meter and refractometer, respectively. Air temperature was also recorded. Each factor was measured in three replicates. In October when jellyfish bloom occurred, species of jellyfish were classified and recorded at the study sites using the key by Buabanjong et al. (2543 B.E.). Data collected in this study were compared with previous data from the study of phytoplankton in 2014 (Ref) and the record from the Hydrographic Department of the Royal Thai Navy.

**Results**

Sea water temperature measured in each month were not different across four study sites (Figure 2). But the highest temperature was observed in October for every sites. The pH of sea water was not different among sites during four months of collection time (Figure 3). The salinity of sea water was 30 ppt for all sites during the time of collection except that of Site 2 in November, which the salinity slightly increased (Figure 4). Air temperature varied greatly during four months of collection time. The highest temperature was observed in October for each study site. (Figure 5). But the highest air temperature recorded in October was found at Site 4.

![Figure 2](image)

Figure 2. Sea water temperature at 4 study sites measured during September to December 2015. The asterisk indicates the jellyfish bloom.
Figure 3. Sea water pH at 4 study sites. The asterisk indicates the jellyfish bloom.

Figure 4. The salinity of sea water at study sites. The asterisk indicates the jellyfish bloom.
When compared the data with previous records (the Hydrographic Department of the Royal Thai Navy), the average sea water temperature in Sattahip Gulf was slightly lower in October during the jellyfish bloom. Air temperature from 2013 record was lower than that of 2014 data during September and December. In addition, sea water temperature at site 1 and 2 in 2013 was also much lower than 2014 records. The pH at site 1 and 2 in 2013 showed more basic than that of this study. The salinity of sea water at these sites was greater than the data from this study.

The common jellyfish species found in October at 4 sites were the moon jelly (*Aurelia* sp.), the presence of the sea nettle (*Chrysaora* sp.) was occasionally observed but not frequently.

**Discussion**

The jellyfish bloom appeared to be related with high sea water temperature and low salinity. At the time of jellyfish bloom in October, sea water temperature was higher than that in other months when no jellyfish bloom occurred. The previous data also showed high sea water temperature recorded when jellyfish bloom similar to this study. The recorded sea water salinity in this study was also lower than previous records. On the other hand, pH of sea water was about 8 for all sites during the collection times. Air temperature varied with season and did not show any association with the jellyfish bloom.
Nevertheless, the data from this study were collected only once a month and only one episode of jellyfish bloom was represented. Although both sea water temperature and salinity showed some association with jellyfish bloom, long term studies would better confirm and clarify the relationship between physical characteristics of sea water and jellyfish bloom. Other factors, such as food availability and the abundance of predators, might influence jellyfish bloom.

Acknowledgements

The authors would like to thank Ms S. Bhudhabhum for advice, Mr. S. Krudamrong and Mr. N Somnet from the Marine Science Learning Center for lending a boat and vehicle during the study. The Institute for the Promotion of Teaching Science and Technology (IPST) and The GLOBE Program and the director at Plutaluangwittaya School for support.

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http://www.been-seen.com/article.cfm?id=11045 (retrieved 1 October 2014)
Efficiency of elephant dung sheets for conservation of soil and water

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Advisor: Mr. Vithiwat Raksapukdee, Thatumprachasermwit School, Surin Province
Co-advisor: Dr. Y. Tokiri, Surindra Rahabhat University, Surin Province

Abstract

A common practice of rubber tree plantation in the South and East of Thailand has been spread into the Northeastern area. About 1-2-year-old young rubber trees could not tolerate drought, resulting in high mortality rates and the loss of income. The use of organic wastes, especially elephant dung, which is abundant in Thatum District, could help alleviate this loss. Elephant dung sheets were designed and used as soil coverage to prevent water loss. Two types of crops, the rubber tree and lime tree, were used to studied the efficiency of elephant dung sheets. The results showed that elephant dung sheet made from 1 kg elephant dung and 0.5 kg flour with 2 liters of water and compressed with the automatic compression machine provided the best quality. The moisture of soil covered with dung sheet was higher than covered with the other materials. Soil temperature was reduced. Nitrate and phosphorus in soil was remained at high level. Soil pH was slightly acidic to neutral. No weeds were found. Both crops showed the highest growth rates compared to other covering materials. Lime trees survived better than rubber trees in soil without any covering.

Keywords: elephant dung sheet, weed, soil and water conservation, elephant village

Introduction

Farmers in Thatum District, Surin Province, have shifted their crop cultivation from growing rice to planting rubber trees. They also plant lime trees in closed containers to earn extra income. However, recent drought had caused high mortality rates in young rubber trees of 1-2 years old. Re-planting the trees cost a lot of money, time, and very labor intensive. Newly planted trees experienced weed infestation because weeds tolerated drought better than crops. The use of herbicides not only cost money but also polluted the environment. The alternative solution was favorable.
Thatum District is the home of the largest elephant village in the world and also serves as the Elephant Learning Center. Therefore, elephant dung is the most common organic waste found in the district. The daily average amount of elephant dung between 3,000 – 4,000 kg is becoming waste generated from Thai Elephant Conservation Center, 2547 B.E. As a result, the use of this waste to solve the drought problem could reduce the amount of organic waste, the use of herbicides, and the loss of money for crop cultivation. The design and development of elephant dung sheets was proposed and tested for their efficiency in soil and water conservation.

Objectives

1. To design and develop the compressor for making sheets
2. To design and develop elephant dung sheets
3. To study/test/evaluate the efficiency of the sheets on soil moisture retaining

Research Questions

1. Were elephant dung sheets efficient for soil and water conservation?
2. How did crops grow and survive with the use of elephant dung sheets?

Hypotheses

1. Elephant dung sheets could provide better results than other materials.
2. Elephant dung sheets could increase growth rates of the crops and reduced mortality rates under drought condition.

Materials and Methods

- The design and development of the compressor for making sheets

Three different designs were compared: a rectangular wooden mold, a hydraulic compressor, and an automatic compressor machine. The use of a rectangular wooden mold required human force to press the materials into a mold. The hydraulic compressor also required human force but with a system that reduced the use of force. An automatic compressor machine required no force to make sheets. These designs were evaluated based on strength, durability, number of sheets produced in an hour and shapes of the products.
The design and development of elephant dung sheets

The materials for making elephant dung sheets were starch, water, and elephant dung. The starch was used as an adhesive. Thus, the amount of starch was varied as in Table 1, while two litres of water and half a kilogram of elephant dung were kept constant. Five ratio combinations of materials were tested. Then, the best design was used to test for its efficiency for soil and water conservation.

Table 1. Composition ratio of materials used for making elephant dung sheets.

<table>
<thead>
<tr>
<th>Combinations</th>
<th>Starch (g)</th>
<th>Water (L)</th>
<th>Elephant dung (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>200</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>250</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The examination of elephant dung sheet efficiency

The study area was located in Thatumprachasermwit School, Surin Province. There were a rubber tree plantation and a lemon tree farm in the school. Fifteen trees for each crop were selected for the study. Soil under the trees was covered with different materials and collected for the examination of soil characteristics. Five trees of each crop were covered with elephant dung sheets, five trees were covered with poster paper and the remaining trees were not covered. Soil samples were collected three times on the 18th, 25th of January and 1st February in 2015. The samples were brought to the laboratory to measure for temperature, humidity, nitrogen (N), phosphorus (P), potassium (K), and pH following the GLOBE protocol. Height of trees was used as an indicator of growth. The presence of weed was recorded. Survival rates of the crops were determined.

Results

The design and development of the compressor for making sheets

All sheets produced from three compressor designs were satisfactory functionable because they could maintain soil humidity and prevent weed growing. However, the automatic compressor machine was the most favorable in terms of sheet’s quality and performance (Table 2). Sheet products from this compressor
were the strongest and hence the most durable compared to those made from the other compressor designs. Furthermore, this design produced the greatest number of sheets per hour with regular uniform shape. The production cost 9 Baht/ sheet, but sold for 25 Baht/ sheet resulting in a profit of 16 Baht/ sheet.

Table 2. Evaluation of three compressor designs based on produced sheet quality and performance.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Quality/ performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rectangular wooden mold</td>
</tr>
<tr>
<td>Strength</td>
<td>Fair</td>
</tr>
<tr>
<td>Durability</td>
<td>1-3 months</td>
</tr>
<tr>
<td>Number of sheets produced per hour</td>
<td>4-8</td>
</tr>
<tr>
<td>Shape</td>
<td>Average</td>
</tr>
</tbody>
</table>

- The design and development of elephant dung sheets

The most favorable combination of materials was the mixture of 250 g of starch, 1 L of water, and 0.5 kg of elephant dung (Table 3). Sheets produced from lower amount of starch broke easily. In contrast, very wet sheets were produced from higher amount of starch. The wet sheets were difficult to take out of the compressor and they also required more drying time.
Table 3. Elephant dung sheet properties producing from different ratio of materials.

<table>
<thead>
<tr>
<th>Ratio of starch: water: elephant dung (g): (L): (kg)</th>
<th>Properties of elephant dung sheets</th>
</tr>
</thead>
<tbody>
<tr>
<td>100: 1: 0.5</td>
<td>Not sticky, sheets did not captured in shape, easily broken</td>
</tr>
<tr>
<td>150: 1: 0.5</td>
<td>Not sticky, sheets captured in shape but not durable</td>
</tr>
<tr>
<td>200: 1: 0.5</td>
<td>Well sticky, sheets captured in shape and durable</td>
</tr>
<tr>
<td>250: 1: 0.5</td>
<td>Very well sticky, sheets captured in good shape and very durable</td>
</tr>
<tr>
<td>300: 1: 0.5</td>
<td>Too sticky, sheets captured in good shape, extremely durable, but dried very slowly</td>
</tr>
</tbody>
</table>

The examination of elephant dung sheet efficiency

The use of elephant dung sheets to cover soil provided different results from using poster paper and bare soil for both types of crops (Table 4). Soil moisture was maintained better with the use of elephant dung sheets as supported with the lower measure of soil temperature. The amount of nutrients in the soil was not significantly different among the three treatments. However, soil pH was lower with the use of the sheets. Plants grew and survived better when the soil was covered with materials, especially the elephant dung sheets.
Table 4. Comparison of soil parameters and survival rate of rubber trees and lime trees with three different treatments of soil

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Rubber trees</th>
<th>Lime trees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil covered with elephant dung sheets</td>
<td>Soil covered with poster paper</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>7.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Efficiency (%)</td>
<td>27.78</td>
<td>21.21</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>29.54</td>
<td>31.90</td>
</tr>
<tr>
<td>N (mg/kg)</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>P (mg/kg)</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>K (mg/kg)</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>pH</td>
<td>6.23</td>
<td>6.43</td>
</tr>
<tr>
<td>Growth increase (cm)</td>
<td>2.40</td>
<td>2.00</td>
</tr>
<tr>
<td>Presence of weeds</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Survival rate (%)</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Discussion

Elephant dung is waste and usually disposed without use. In fact, it can be valuable and used for covering soil to prevent water loss in drought condition. An automatic compressor machine was the most favorable for making elephant dung sheets because it provided the best quality products in terms of strength, durability and the high production rate per hour. The mixture of 250 g of starch, 1 L of water, and 0.5 kg of elephant dung yielded the best quality products. Furthermore, the profit margin of 16 Baht/ sheet (almost 200%) would provide local people with more income.

The use of elephant dung sheets to cover the soil was quite effective because soil moisture was retained promoting growth of the crops (Tungmun et al., 2555 B.E.). Slightly acidic soil as a result of the use of elephant dung sheets was probably the decomposition of this organic matter that decreased soil pH. Nevertheless, the soil was still good for plant growth as indicated from the increase of growth for both crops. Although poster paper also provided similar results and easier to find, the use of organic materials, in this case elephant dung sheets, would be more beneficial since they are naturally decomposed. In addition, elephant dung sheets were reported to absorb atmospheric moisture (Raksapukdee, 2012). This would be beneficial during drought conditions when water is scarce while crops still need water. The development of elephant dung sheets for soil coverage reduces the cost and the use of dangerous herbicides. Since elephant dung is widely abundant in the community, the production of the sheets should be merchandized. This provides more job opportunity for local people and further promotes the Return of Elephants to Surin Province.

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Physical characteristics of water and diversity of benthic invertebrates in Sam Peuy River

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Co-advisor: Assist. Prof. Surajit Pramuang, Loei Rajabhat University

Abstract

Sam Peuy River is a very important water resource for people in Pa Sam Yod Village in Pukradung District, Loei Province, Thailand. Agricultural and household uses for this water source are intense and could affect water quality. This study was proposed to examine physical characteristics of water and diversity of benthic invertebrates in this river as they could be used for indications of water quality. Water samples were collected from upstream to downstream for the total of 5 locations. The results revealed that water temperature at all sampling locations ranged from 20 to 27°C while air temperature ranged between 23-32°C. The pH of water was neutral, and water transparency varied from 20 to 40 cm. DO ranged from 5.07 to 6.43 mg/L. The index of water quality based on the diversity of benthic invertebrates indicated good water quality with the highest value at the 4th sampling location in downstream.

Keywords: Sam Peuy River, water quality, water quality index, benthic invertebrate

Introduction

Physical characteristics of water are general indicators of water quality and convenient to examine. At present, diversity of benthic invertebrates found in water sources becomes popular as bio-indicator in addition to other characteristics (Inmuang et al., 2540 B.E.). Benthic invertebrates are important components in the ecosystem because they drive nutrient cycles, decomposition of organic matter, and also serve as food for other animals. The diversity of benthic invertebrates in a system reflects water quality of the area (Sangpradup, 2549 B.E.). High diversity usually indicates clean water with high oxygen content, but species of the animals
are also important. Larvae of mayflies and caddisflies are usually found in clean water while larvae of dipterans are generally associated with polluted water due to their high tolerance to pollution. Therefore, the examination of benthic invertebrates could be used as indicators for water quality.

One of the important water resources in our community is Sam Peuy River in Pa Sam Yod Village, in Pukradung District, Loei Province. This river flows through the village and provides water for agriculture and household consumption. Unfortunately, waste water is also disposed into the river as well. Water is turbid and light brown in color. Aquatic plants, such as the exotic water hyacinth and sages, are found. Because of the activities of the villagers, water quality in this river may be affected, and it becomes an urgent issue to monitor the quality of water for future development of the community.

Objectives

1. To compare water quality between upstream and downstream of Sam Peuy River
2. To examine the diversity of benthic invertebrates between upstream and downstream of Sam Peuy River
3. To examine physical characteristics of water

Research Questions

1. What were the differences in physical characteristics of water between sampling locations of Sam Peuy River?
2. How benthic invertebrates were different at all sampling locations?

Hypotheses

1. The upstream area would show better water quality than would the downstream area because the river flowed through the village where intense use of water occurred.
2. The diversity of benthic invertebrates at the upstream area was greater than that of the downstream area because these invertebrates were the indicator of water quality.
Materials and Methods

- **Sampling locations**
  
  Five locations were assigned for water collection (Figure 1). The first location was the most upstream area of Sam Peuy River flowing through the village. The second location was the area further downstream before the river reaching the village. The third location was in the middle of the village. The fourth location was further downstream at the back of the village. The last location of the most downstream area before the river discharging into Pong River.

- **Examination of physical characteristics of the water**

  1. **Temperature**

     Both air and water temperatures were measured using hand-held thermometers. Water temperature was measured by submerging the thermometer in the water and recording the readings as suggested in the GLOBE protocol (IPST, 2010).

  2. **Water pH**

     Water samples were collected and stored in bottles. Universal indicator paper was dipped into the water. The color appeared on the paper was compared with the standard as suggested in the GLOBE protocol (IPST, 2010).

  3. **Water transparency**

     Secchi Disc was immersed into the river at sampling locations until the disc disappeared from the view. The length of the ropes was measured and recorded as suggested in the GLOBE protocol (IPST, 2010).
4. Dissolved oxygen (DO)

Water was collected and brought to the laboratory for analyses following the protocol by Pradthana’s Weblog (2014).

- **Examination of benthic invertebrates**

  Dip nets were used for collecting benthic invertebrates. The nets were dragged for the distance of 50 cm. Sediment samples were placed in plastic bags and brought to the laboratory. Species of benthic invertebrates were identified following the key (Kanchanawanit, 2002). The water quality index was calculated based on species and number of benthic invertebrates (Green World Foundation, 2004).

**Results**

1. Physical characteristics of water in Sam Peuy River

   The results were recorded in Table 1. Both air and water temperatures from upstream and downstream locations were different. Low temperatures were observed at the most upstream area (location 1). The temperatures increased as the river moved further downstream. Water pH was neutral and not much different among the sampling locations. Water was most transparent at the 4th location and most turbid at the 3rd location. DO was highest at the most upstream location and lowest at the most downstream location.

Table 1. Physical characteristics of water at five sampling locations of Sam Peuy River.

<table>
<thead>
<tr>
<th>Location</th>
<th>Temperature (˚C)</th>
<th>pH</th>
<th>Water transparency (cm)</th>
<th>DO (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water</td>
<td>Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Upstream</td>
<td>20</td>
<td>23</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>2 Before river reaching village</td>
<td>25</td>
<td>26</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>3 Middle of village</td>
<td>26</td>
<td>27</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>4 Back of village</td>
<td>26</td>
<td>32</td>
<td>7</td>
<td>40</td>
</tr>
<tr>
<td>5 Downstream</td>
<td>27</td>
<td>31</td>
<td>8</td>
<td>25</td>
</tr>
</tbody>
</table>
2. Examination of benthic invertebrates

Different species were found at different locations (Figure 2). No invertebrates were collected from the most upstream and downstream locations (Table 2). Highest diversity was observed at the 4th location while the highest number of invertebrates was recorded at the 2nd location. The calculation for water quality index showed that water the 2nd and 4th locations was clean while the water at the middle of the village was relatively clean.

![Image of Tarebia granifera (Gastropoda)](image1)

Tarebia granifera (Gastropoda)

![Image of Small shrimp](image2)

Small shrimp

![Image of Planarian](image3)

Planarian

![Image of Mayfly larva (Ephemeroptera)](image4)

Mayfly larva (Ephemeroptera)

![Image of Chironomid larva (Diptera)](image5)

Chironomid larva (Diptera)

Figure 2. Benthic invertebrates collected from five sampling locations of Sam Peuy River
Table 2. The diversity and number of benthic invertebrates found at five sampling locations of Sam Peuy River.

<table>
<thead>
<tr>
<th>Location</th>
<th>Species Identification</th>
<th>Number (individuals)</th>
<th>Score</th>
<th>Water quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Upstream</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2 Before river reaching village</td>
<td><em>Tarebia granifera</em> (Gastropoda)</td>
<td>10</td>
<td>15</td>
<td>5 Clean</td>
</tr>
<tr>
<td></td>
<td>Small shrimp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Middle of village</td>
<td><em>Tarebia granifera</em> (Gastropoda)</td>
<td>15</td>
<td>2</td>
<td>4.3 Relatively clean</td>
</tr>
<tr>
<td></td>
<td>Chironomid larva (Diptera)</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planarian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Back of village</td>
<td><em>Tarebia granifera</em> (Gastropoda)</td>
<td>5</td>
<td>1</td>
<td>6.2 Clean</td>
</tr>
<tr>
<td></td>
<td>Chironomid larva (Diptera)</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mayfly larva (Ephemeroptera)</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Phylloda</em> (Bivalvia)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Downstream</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Discussion and Conclusions**

The overall water quality of Sam Peuy River flowing through the village was in good quality. The water at the downstream back end of the village still remained in good quality even though waste water from household consumption and agriculture was disposed into the river. Some factors, such as waste water management strategies, may help remove the waste out of the water. Nevertheless, the absence of benthic invertebrates from the most upstream and downstream locations restricted the evaluation of water quality, and probably due to sampling errors. Better and more frequent sampling may be necessary for future monitoring of water quality of Sam Peuy River.
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References


The use of egg shells and shells of the golden applesnail to increase growth and yield of peanuts

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Abstract

Growth and yield of peanuts are related to the number of root nodules occurring on roots of the plants. Because root nodules are the association between peanut plants and the nitrogen-fixing bacteria in soil, which are called Rhizobium, the increase in the number of root nodules could increase yield of the peanut plants. The use of egg shells best increased the number of root nodules of two varieties of peanut plants (Kalasin 1 and Kalasin 2). The use of shells of the golden applesnail provided the second best result. The increase in the number of root nodules promoted plant height and yield.

Keywords: peanut plants, Rhizobium, calcium, egg shell

Introduction

The symbiotic relationship between legume plants and the nitrogen-fixing bacteria, Rhizobium, in soil can be useful for farmers to cut their cost, increase their products, and reduce the use of synthetic fertilizers, which could destroy soil (Department of Agriculture, 1992). The number of root nodules is associated with the amount of calcium in soil (Panyajeen, 2009). Local farmers have mixed egg shells with soil for growing crops. Egg shells are full of essential nutrients, such as calcium and magnesium (Damrongpokkapan, 2012). In addition to egg shells, shells of the exotic golden applesnail could also be sources for calcium. Because this exotic species is abundance in the region, they should be removed from the environment and used to increase crop yield.

Peanuts are one of the agricultural products that are produced in Kalasin Province. Because peanuts are legume plants that have an association with Rhizobium, the increase in the number of these bacteria, which could be represented
as the number of root nodules, could be beneficial to farmers. Peanuts provide an alternative source of income for farmers in addition to rice and also help improve soil nutrients.

**Research Questions**

1. Did egg shells and shells of the golden applesnail increase the number of root nodules of peanut plants?
2. How did the use of egg shells and shells of the golden applesnail affect the growth and yield of peanut plants?

**Hypotheses**

1. Egg shells and shells of the golden applesnail are good sources of calcium, which is an essential element for the formation of root nodules in peanut plants. The use of these additional sources of calcium could promote the increase in the number of root nodules of peanut plants.
2. The increase in the number of root nodules of peanut plants could promote growth and yield of the plants because they could be able to utilize soil nutrients with the help of the symbiotic nitrogen-fixing bacteria, *Rhizobium*.

**Materials and Methods**

Two varieties of peanuts, Kalasin 1 and Kalasin 2, were selected for the experiment. The experiment included three treatments for each peanut variety. Soil for the experiment was measured of its moisture, pH, and basic nutrient contents (N, P, and K) before use. The first treatment was the use mixture of 5 kg of soil and 2.7 g of ground egg shells (adapted from Duangpattra, 1992). The second treatment was the mixture of 5 kg of soil and 2.7 g of ground shells of the golden applesnail. The third treatment was the control that contained only 5 kg of soil. There were 18 replicates for each treatment making the total of 54 samples for a variety of peanut.

Three seeds of each variety were planted for each sample. The soil was watered once a week with the same amount of water (300 cm$^3$). After two weeks, only one plant from each sample was selected, and the other plants were removed. The number and weight of root nodules and plant height were measured monthly for three months. After three months, the products of peanut plants were harvested. The number and weight of pods were examined.
Results

The number of root nodules of both peanut varieties grown with the addition of calcium sources was greater than the control (Figure 1). Plants grown with the mixture of egg shells produced more nodules than other treatments for both varieties. The control treatments showed lowest number of root nodules. The weight of root nodules under different treatments was different (Figure 2). Plants grown with the mixture of egg shells produced the largest root nodules compared to the other treatments. The control produced the smallest root nodules. Height of peanut plants under different treatments was also different (Figure 3). The highest plants were observed when plants were grown with the mixture of egg shells while the shortest plants were the control.

At the end of the experiment, the pods of peanuts were harvested (Figure 4 and 5). The products of plants grown with the mixture of egg shells provided the highest yield in terms of the number of pods and weight while the control provided the lowest yield.

Figure 1. The number of root nodules found in roots of both peanut varieties during 3 months.
Figure 2. The average weight of root nodules of both peanut varieties during 3 months.

Figure 3. The height of peanut plants of both peanut varieties during 3 months.

Figure 4. The average number of harvested peanut pods of both peanut varieties.
Discussion

The use of egg shells and shells of the golden applesnail promotes growth and yield of peanut plants. Egg shells provided slightly better results than did the shells of the golden applesnail. The number and weight of root nodules and plant height were greatest with the use of egg shells, which were rich in calcium. Previous experiments also support the results from this study (Kamhan, 2003). Calcium promotes the formation of root nodules and results in greater yield (Panyajeen, 2009). Based on the data from this study, the greatest growth of plants also resulted in the highest yield. Therefore, the use of egg shells for additional source of calcium is useful. Because egg shells are available locally as household organic wastes, they could be used in agriculture instead of synthetic materials. In addition, the golden apple snails, which are exotic pests in rice fields, could also serve as the calcium source. Because of their abundance locally, the use of this species could improve the environment by removing pests and using them to enrich the soil. Although the egg shells provided better results, the use of the shells of the golden applesnail would still be important and should be promoted.

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Natural Innovative Water Retention Mimicry Bromeliad  

(Aechmea aculeatosepala)

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Abstract

The natural innovative water retention mimicry of the Bromeliaceae was aimed to examine the efficacy of the natural water collection by the plants regarding to the shape of the plants that can collect and capture the water. The literature review demonstrated that Aechmea aculeatosepala can grow in the barren area because of its suitable retention and entrapment structure. In present study, a water retention model has been developed in the mimicry of the Bromeliaceae.

The finding indicated that Aechmea aculeatosepala constitutes crucial multiple parts to retain water, the leaf which the two sides of the marginal leaf is thinner than the mid leaf, and leaf blade with U-shaped trough, enables the water flow to the catchment between leaf sheath (Rosette), tiny thorns around the leaf at the angle of 50 degrees to the marginal leaf draws the water, 2 mm away from the marginal, into the leaves. Front and dorsal surface of the leaves allows water to flow down and gather together at the trough because the adhesive force between the water and surface is greater than the cohesive force of the water. In addition, the mimic water retention of the Aechmea aculeatosepala is caused by the overlapping leaves; the lower part of the leaf blade extends and featured of cone-like storage basin at the mid trunk, and in the between leaf axils, water is retained much more than cone-like container by 17.28 percent.

In details, Aechmea aculeatosepala was adopted to model the mimic water retention device, made of aluminum sheet because of its less heat capacity. At the night, when influenced by the water vapor in the air, it is easier to condense into a drop of water. In the real application of the device, the unit is installed on the rubber tree, Thailand’s economic crop, 3 units for each tree, a total of ten rubber trees. The
salt tube is grounded 1 meter distanced from the stubs. It found that soil moisture when the device is installed represents 17.65 percent greater than that non-installation and non-watering. Also, it found that the soil moisture is close to the normal watering; 9.80 percent less than normal watering. In addition, the device-installed rubber tree is 57.50 percent more productive than non-installed rubber trees at unit cost of 25 Baht and break-even point is 6 days only.

**Keywords:** Water Retention, Bromeliad (Aechmea aculeatosepala)
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