Effect of different fertilizers on plant productivity in Malaysian upland rice

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For APAN 37th Meeting, Bandung, Indonesia
A report by Malaysian National Committee on Irrigation and Drainage (MANCID) stated that the paddy growing area is expected to decline with time as a result of conversion of paddy land for other land use including urbanization. It is forecasted that paddy growing-area will decline to about 475,000 ha in the year 2005 and 450,000 ha by the year 2010. Therefore, the use of upland rice is a good alternative in order to overcome this situation as wet paddy needs large lowland area with complex irrigation system.
Outline

Introduction

Related works

Methods

Current progress

Summary

Future works
Introduction

Food security in Malaysia – more than 50% of food imported including its staple food, rice.

Self-sufficiency level (SSL) of rice in Malaysia is targeted to achieve 70% by 2015.
- To increase production of rice.

Only 15% of land is used for growing food crop.
1) Malaysia is one of the most import-dependent countries in the world where more than 50% of the food is imported. Malaysia will import as necessary to ensure sufficient supply of rice for domestic consumption.

2) Therefore, the government has targeted to achieve 70% of self-sufficiency level (SSL) on rice in 10th Malaysia plan with the major current focus is to increase the production of rice.

3) Planted areas of rice in Malaysia

<table>
<thead>
<tr>
<th>Type of rice</th>
<th>Planted areas, ha</th>
<th>Production, metric tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland</td>
<td>617 028</td>
<td>1 623 102</td>
</tr>
<tr>
<td>Upland</td>
<td>70 912</td>
<td>38 158</td>
</tr>
<tr>
<td>Total</td>
<td>687 940</td>
<td>1 661 260</td>
</tr>
</tbody>
</table>
Rice production in Malaysia, 2011

Source: Department of Agriculture, Malaysia (2012)
The cultivation of upland rice is unlikely favorable in Malaysia.

Upland rice is grown aerobically in upland environments, mostly by rural communities in Sabah and Sarawak (Paul Vincent, 2010).

Research on upland rice has been neglected because of its low yield and unstable grain yields, even though it is widely grown in the interior parts of the country (Mariam et al., 1991).

Chan et al. (2012) claimed that upland rice are not responsive to external inputs such as fertilizer and water.

However, some of the varieties exhibit desirable characteristics - good fragrance, long grains and can be cultivated on dry land without accumulation of water.
2) Upland rice is planted in fields with naturally well drained soils and no surface water accumulation. It supports the majority of the rural communities, most of them at the subsistence level.

3) The upland rice can give stable but low yields in adverse environments where rainfall is low, irrigation is absent, soil texture is poor or toxic, weed infestation is high, farmers are too poor to supply high inputs and rice is grown as a subsistence crop.

5) Flooding during the earlier part of the year and the emergence of weed contributed to the unstable production of wetland rice.
Objectives

1. To compare the effect of fertilizers on plant growth parameters and soil characteristics from vegetative until maturity stage.

2. To assess the effect of fertilizers on plant productivity and grain quality in upland rice.
<table>
<thead>
<tr>
<th>References</th>
<th>Type of fertilizer</th>
<th>Type of rice</th>
<th>Significant findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farah et al., 2014</td>
<td>Biofertilizer (EM), organic (compost + pellet granule), inorganic (urea + superphosphate)</td>
<td>Wetland: Kosti 1, Umgar (Sudan)</td>
<td>High yield 2.97 t/ha was obtained by EM - Kosti 1</td>
</tr>
<tr>
<td>Vahed et al., 2012</td>
<td>Phosphate chemical fertilizer (with phosphate solubilizing bacteria)</td>
<td>Wetland (Iran)</td>
<td>PSB treatment a month after transplanting had significant influence on grain yield, 4613 kg/ha, compared to control, 3515 kg/ha.</td>
</tr>
<tr>
<td>References</td>
<td>Type of fertilizer</td>
<td>Type of rice</td>
<td>Significant findings</td>
</tr>
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</tr>
<tr>
<td>Naing Oo et al., 2010</td>
<td>Chemical fertilizer</td>
<td>Wetland (Laos)</td>
<td>Chemical fertilizer: 3.0 t ha(^{-1}) Residues: a yield increase of 12-28% Combination of Chemical fertilizer &amp; Residues: a yield increase of 15-35%</td>
</tr>
<tr>
<td></td>
<td>On-farm residues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myint et al., 2010</td>
<td>Organic fertilizer (cow manure, poultry manure) and mineral fertilizer (rice straw + urea, M-coat, urea)</td>
<td>Wetland: Manawthuka (Japan)</td>
<td>Dry matter and grain yield in M-coat was the highest in amount (about 34% higher than Control)</td>
</tr>
<tr>
<td>References</td>
<td>Type of fertilizer</td>
<td>Type of rice</td>
<td>Significant findings</td>
</tr>
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<td>--------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Saito et al., 2005</td>
<td>Chemical fertilizer (N: urea, P: triple superphosphate, NP: both)</td>
<td>Traditional and improved upland varieties (Laos)</td>
<td>N application increased grain yields of two improved cultivars from 3.1 to 4.0 t/ha and increased traditional cultivars from 1.6 to 1.9 t/ha.</td>
</tr>
</tbody>
</table>
| Linquist et al., 2007 | Organic fertilizer: Farmyard manure (FYM)  
Inorganic fertilizer: Chemical fertilizer (NPK) | Black glutinous upland rice (Thailand) | Combination of FYM & NPK improved plant productivity and grain yield.                            |
Flowchart

1. Plant materials
2. Soil preparation
3. Planting site preparation
4. Plant growth
5. Phenotypic evaluation
6. Statistical analysis
7. Plant productivity evaluation
8. Plant harvesting
Plant materials

- Two local upland rice landraces are used in this study.

**Panderas (Pahang)**
- 78% carbohydrate
- 7% protein
- Energy: 344 kcal/100g

**SK1 (Sarawak)**
- 80% carbohydrate
- 5.7% protein
- Energy: 365 kcal/100g
Planting area

- Pot experiment is conducted at Agriculture Site, Faculty of Education, UTM following CRD with 3 replications.
- Plant house temperature ranging from 27-38°C.
Soil & Fertilizers

1. Bio organic
   - N: 8 P: 2 K: 4

2. Chemical
   - N: 15 P: 15 K: 15

3. Biochemical
   - N: 8 P: 8 K: 20

Soil used in the experiment is sandy clay loam (68.19, 23.86 and 7.95% sand, clay and silt, respectively).
Soil properties

- Macronutrient+micronutrient
  - Na – 219; P – N/A; K - 8.1; Mg – N/A; Ca – 32; Fe – 1.73; Mo- 0.04; B- < 0.05
  - pH: 4.99, 4.97, 4.94, 5.01, 5.04, 5.00 ~pH5

- Hydrometer test- gravimetric water content (GWC) = 0.0569
Fertilizing condition

- Time of applying fertilizer (Myint et al. 2010)
  1. Basal application
  2. Active tillering – day 45 after sowing
  3. Panicle initiation – day 90 after sowing

- Biochemical fertilizers to apply
  - N:11 P:11 K:11 (basal, day 45)
  - N:8 P:8 K:20 (day 90) * as recommended by manufacturer
Current progress

- Observation of plant growth characteristics and data recording
  1. Plant height – measured at day 30, 60 and 90 (monthly).
  2. Culm number – recorded at day 90.

- Microbe presence on soil samples
  1. Lactobacillus
  2. Yeast
  3. Nitrogen fixing bacteria
  4. Nitrifying bacteria
Culm

Panderas

- Control
- Chemical
- Biochemical
- Bio organic

SK1

- Control
- Chemical
- Biochemical
- Bio organic
Graph 1: Culm number in response to fertilizers

No. of Culm

Treatment

Biochemical | Chemical | Bio Organic | Control

CulmSK1  | CulmPandrs

Graph 1: Culm number in response to fertilizers
Graph 3: Plant height in response to fertilizers

Plant Height (SK1), cm

Plant Height (Panderas), cm

Days

Biochemical
Chemical
BioOrganic
Control

Graph 3: Plant height in response to fertilizers
Microbe observation

- Lactobacillus
- Nitrogen fixing bacteria
- Yeast
- Nitrifying bacteria
Table: Population size of bacteria detected in soil sample of upland rice after 90 days of growth

<table>
<thead>
<tr>
<th>Landrace</th>
<th>Treatment</th>
<th>Lactobacillus (cfu/g)</th>
<th>Yeast (cfu/g)</th>
<th>Nitrogen fixing (cfu/g)</th>
<th>Nitrifying (MPN/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>NOB</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AOB</td>
</tr>
<tr>
<td>Panderas</td>
<td>Biochemical</td>
<td>3.3 x 10³</td>
<td>1.6 x 10⁴</td>
<td>6.7 x 10⁵</td>
<td>&lt;3</td>
</tr>
<tr>
<td></td>
<td>Chemical</td>
<td>2.5 x 10³</td>
<td>6.2 x 10²</td>
<td>3.5 x 10⁶</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Bio Organic</td>
<td>5.9 x 10³</td>
<td>9.6 x 10³</td>
<td>1.7 x 10⁵</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.6 x 10³</td>
<td>3.3 x 10²</td>
<td>6.7 x 10⁵</td>
<td>absent</td>
</tr>
<tr>
<td>SK1</td>
<td>Biochemical</td>
<td>1.7 x 10⁵</td>
<td>6.3 x 10²</td>
<td>1.3 x 10⁵</td>
<td>9.2</td>
</tr>
<tr>
<td></td>
<td>Chemical</td>
<td>2.6 x 10³</td>
<td>4.8 x 10³</td>
<td>7.7 x 10⁵</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Bio Organic</td>
<td>7.7 x 10³</td>
<td>1.6 x 10³</td>
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<tr>
<td></td>
<td>Control</td>
<td>1.1 x 10³</td>
<td>3.1 x 10³</td>
<td>3.7 x 10⁵</td>
<td>absent</td>
</tr>
</tbody>
</table>

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Summary

The upland paddy is anticipated to be responsive to application of fertilizers.

Bio organic fertilizer is predicted to give the best performance over all treatments.

This study is anticipated to pave the way for the better production technology of upland rice in Malaysia.
Future work

- This study will be extended for field trial of potential upland rice landraces.
- It is to evaluate the effectiveness of the potential fertilizers on improving grain yield of upland rice during field trial.
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Funding:
Universiti Teknologi Malaysia - Fundamental Research Grant Scheme (FRGS) Fund (Q.J130000.2444.00G065)

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THANK YOU.