Azolla fertilizer as an alternative N source for red spinach production on alluvial and peat soils in West Kalimantan, Indonesia

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Introduction

- Food security in Indonesia
- Sustainable Reserve Food Garden Program
- Locally-grown fertilizer

The contributions of *A. pinnata* as a biofertilizer on red spinach production on Inceptisols and Histosols in West Kalimantan, Indonesia
Azolla pinnata

http://www.hear.org/pier/image
pages/singles/azospp11.htm

https://azollablora.wordpress.com/
2013/11/16/berbagai-manfaat-azolla/

http://bharatnamaskar.blogspot.com/
2012/07/super-plants-solution-to-food-water.html
Azolla utilization

Waste water treatment
http://www.folkecenter.net

Animal feed
http://theazollafoundation.org

Food
http://www.eriksjodin.net
Biological nitrogen fixation

*Anabaena azollae* inside the leaf cavities of *Azolla mexicana*

https://www.researchgate.net/profile/Francisco_Carrapico
Study site

✓ Agricultural Research Station and local farmer, West Kalimantan, Indonesia

✓ Sulfic Endoaquepts and Terric Sulfihemists

✓ Tropical moist climate (IIIC and IVC)
  • average T > 18 °C
  • average RH 80.8%
  • annual precipitation 2000-4000 mm
Methods

✓ Randomized Complete Block Design, 3 replicates

✓ Treatments:
  ▪ control
  ▪ urea at 50 kg ha$^{-1}$: $\sim$ 23 kg N ha$^{-1}$
  ▪ chicken manure at 5 t ha$^{-1}$ (3.19% N):
    $\sim$ 108 kg N ha$^{-1}$
  ▪ *Azolla* at the urea N rate (2.88% N):
    $\sim$ 23 kg N ha$^{-1}$
  ▪ *Azolla* at the manure N rate ($\sim$ 108 kg N ha$^{-1}$)
Materials and methods

✓ Spinach: Red “Giti” Spinach (Indonesian Vegetable Research Institute)

✓ Fertilizer application:
  • Plant ash: 3 t ha\(^{-1}\) (peat)
  • Manure and Azolla: 3 DAT
  • Urea: 3 and 14 DAT

✓ Harvesting at 45 days
Methods: Growing *Azolla pinnata*

- T $\leq$ 30 °C and not too much high light intensity
- Inoculation rate: 100-200 g m$^{-2}$
- Plant ash: 0.75 t ha$^{-1}$ (peat)
- *Azolla* harvested at 3-4 weeks
Data collection and analysis

Agronomic parameters:
• Yield
• Plant height
• Leaf and branch numbers
• Leaf N content
• Nitrogen use efficiency (NUE)

Data analysis using SAS 9.4
Results

†Values followed by a different letter indicate significance difference within the same soil based on Tukey’s HSD test (p<0.10)
Results

Values followed by a different letter indicate significance difference within the same soil based on Tukey’s HSD test (p<0.10)
Results

Values followed by a different letter indicate significance difference within the peat soil based on Tukey’s HSD test (p<0.10)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Leaf number</th>
<th>Branch number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>52.47 b‡</td>
<td>9.60 b</td>
</tr>
<tr>
<td>Urea</td>
<td>59.47 ab</td>
<td>9.60 b</td>
</tr>
<tr>
<td>Manure</td>
<td>59.40 ab</td>
<td>10.53 ab</td>
</tr>
<tr>
<td>Azolla~Urea</td>
<td>62.93 ab</td>
<td>10.53 ab</td>
</tr>
<tr>
<td>Azolla~Manure</td>
<td>66.33 a</td>
<td>11.47 a</td>
</tr>
</tbody>
</table>

†Values followed by a different letter indicate significance difference within the peat soil based on Tukey’s HSD test (p<0.10)
Results

Values followed by a different letter indicate significance difference within the same soil based on Tukey’s HSD test (p<0.10)
Nitrogen use efficiency
(Dobermann, 2005):

➢ Agronomic efficiency of applied N = \( \frac{Y_N - Y_0}{F_N} \)

\( Y_0 \) = yield in unfertilized N plot (kg)
\( Y_N \) = yield in N plot (kg)
\( F_N \) = kg N applied
Results

Values followed by a different letter indicate significance difference within the same soil based on Tukey’s HSD test (p<0.10)
Conclusions

✓ The agronomic parameters on the alluvial soil are relatively higher.
✓ Yield and leaf N content respond to fertilizer treatment.
✓ Urea showed significantly highest NUE on the Alluvial soil and *Azolla*~Urea on the peat soil.
✓ *Azolla* applied at the manure N rate can be used as an alternative biofertilizer, especially for peat soil.
Acknowledgements

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• Subroto-local farmer in Siantan, West Kalimantan, Indonesia
Thank You