

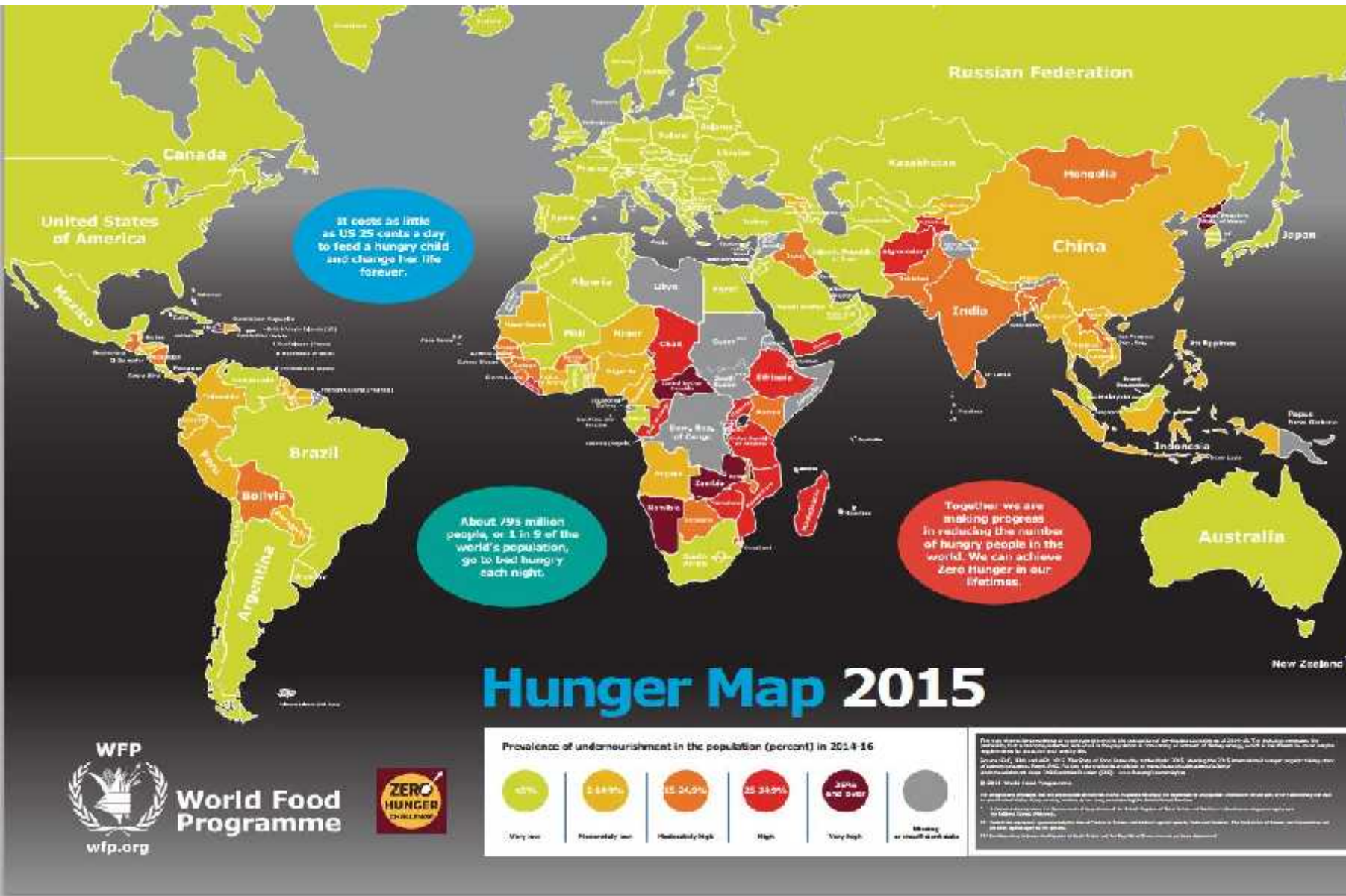


Azolla fertilizer as an alternative N source for red spinach production on alluvial and peat soils in West Kalimantan, Indonesia

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<http://www.rappler.com/move-ph/issues/hunger96163-united-nations-acute-malnutrition-indicator-sdg>

<http://adesojiadegbulu.com/hunger-map-2015/>

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



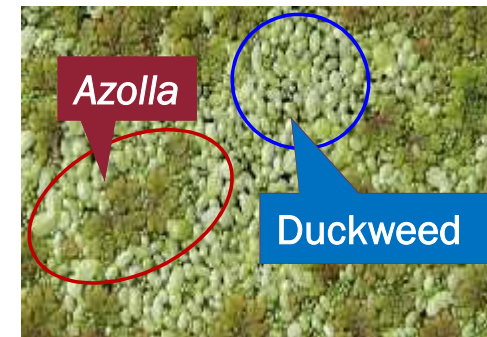
<http://www.hear.org/pier/image/pages/singles/azospp11.htm>



2.5 cm



<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.eriksjudin.net>

Biological nitrogen fixation

Anabaena azollae inside the leaf cavities of *Azolla mexicana*

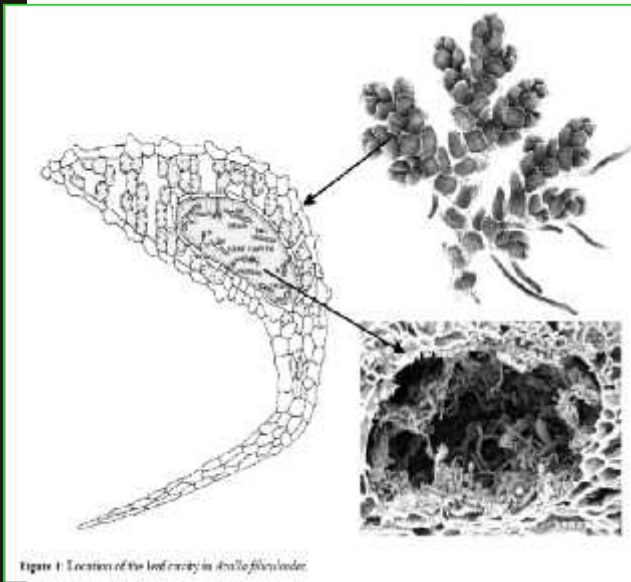
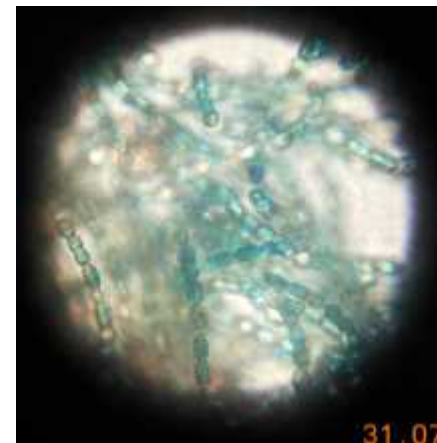
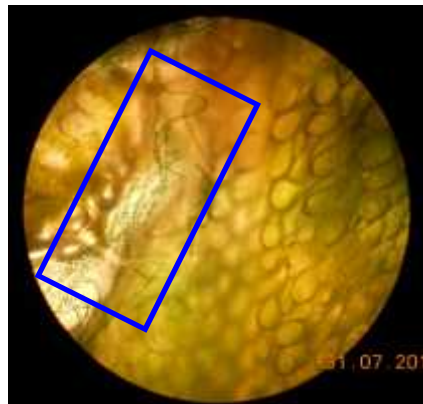


Figure 1. Location of the leaf cavity in *Azolla mexicana*.

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 $T > 18\text{ }^{\circ}\text{C}$
 - average RH 80.8%
 - annual precipitation 2000-4000 mm



<http://www.worldmap1.com>



Indonesian Soil Research Institute, 2004

Methods

- ✓ Randomized Complete Block Design, 3 replicates
- ✓ Treatments:
 - control
 - urea at 50 kg ha^{-1} : $\sim 23 \text{ kg N ha}^{-1}$
 - chicken manure at 5 t ha^{-1} (3.19% N):
 $\sim 108 \text{ kg N ha}^{-1}$
 - *Azolla* at the urea N rate (2.88% N):
 $\sim 23 \text{ kg N ha}^{-1}$
 - *Azolla* at the manure N rate ($\sim 108 \text{ kg N ha}^{-1}$)



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

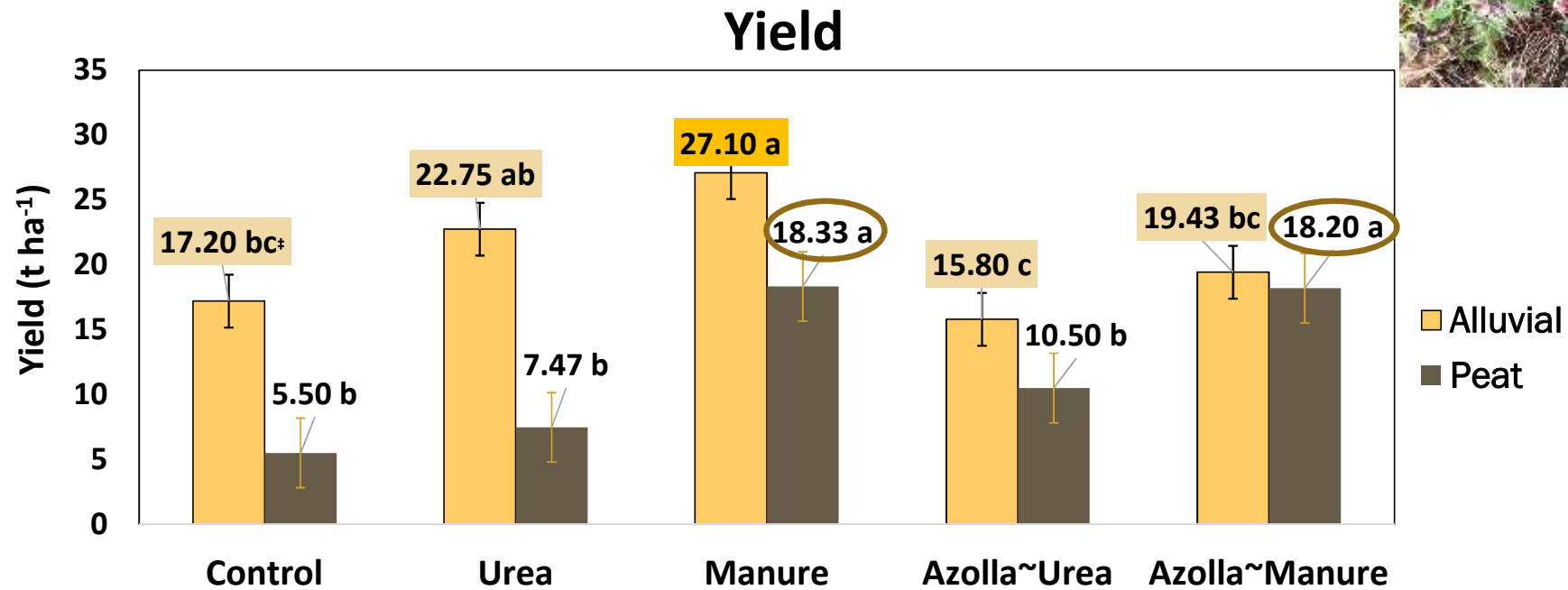
Agronomic parameters:

- Yield
- Plant height
- Leaf and branch numbers
- Leaf N content
- Nitrogen use efficiency (NUE)

Data analysis using SAS 9.4

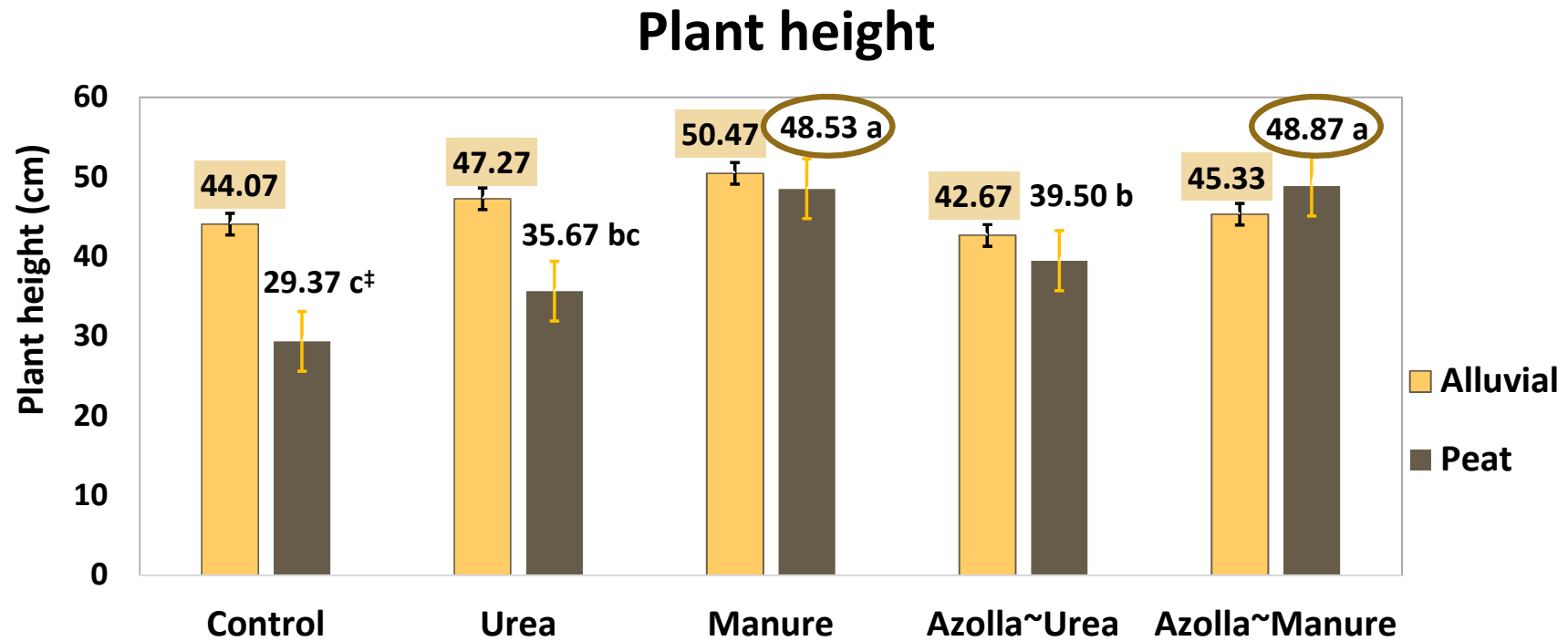


Results



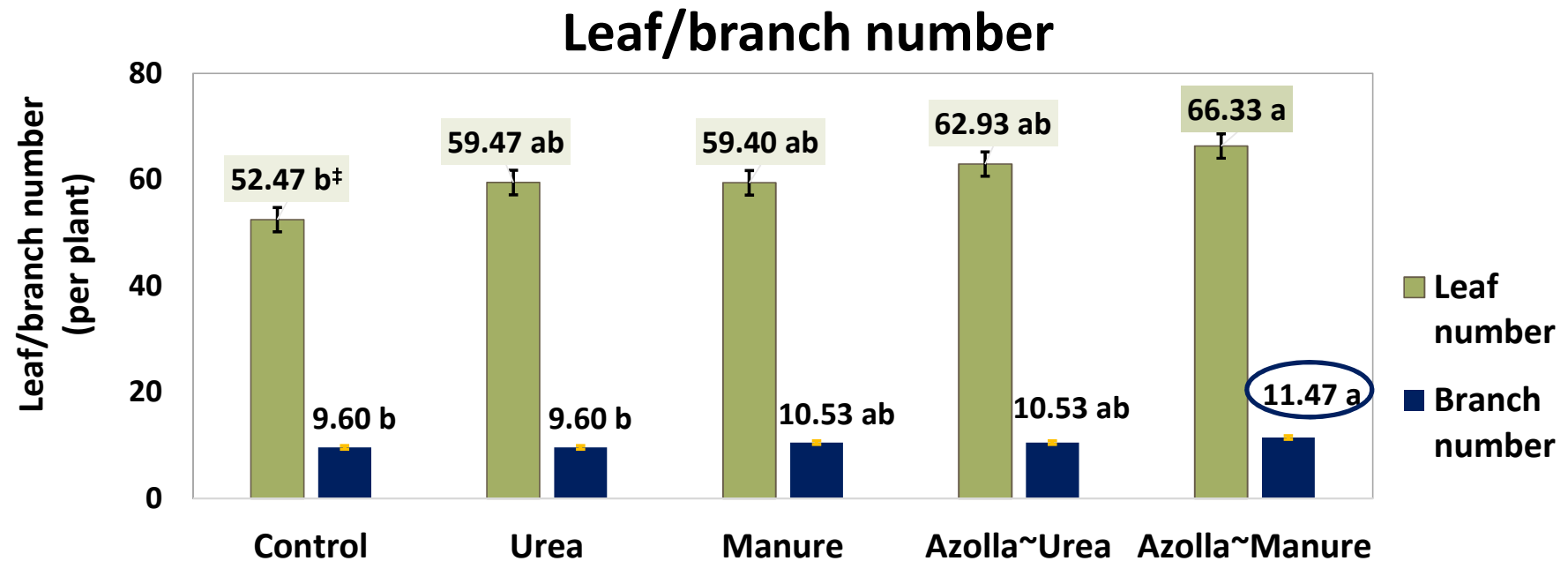
†Values followed by a different letter indicate significance difference within the same soil based on Tukey's HSD test ($p < 0.10$)

Results



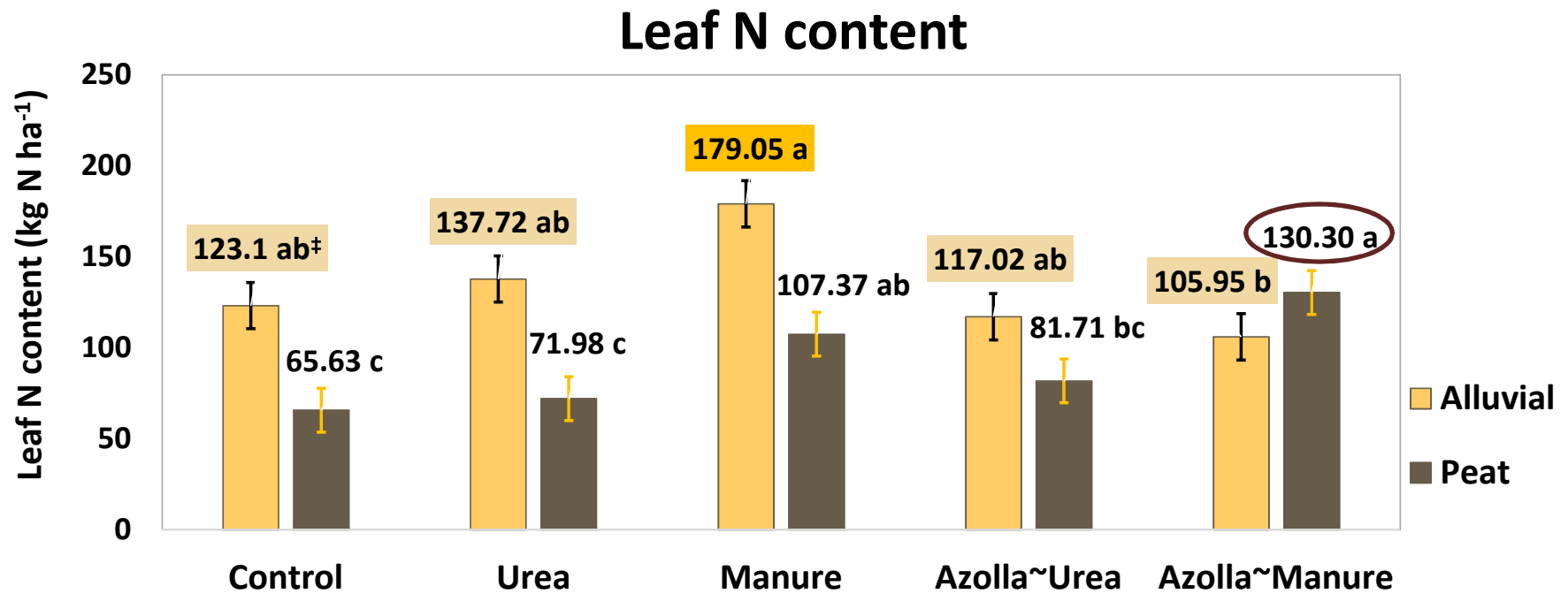
†Values followed by a different letter indicate significance difference within the same soil based on Tukey's HSD test ($p < 0.10$)

Results



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

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):

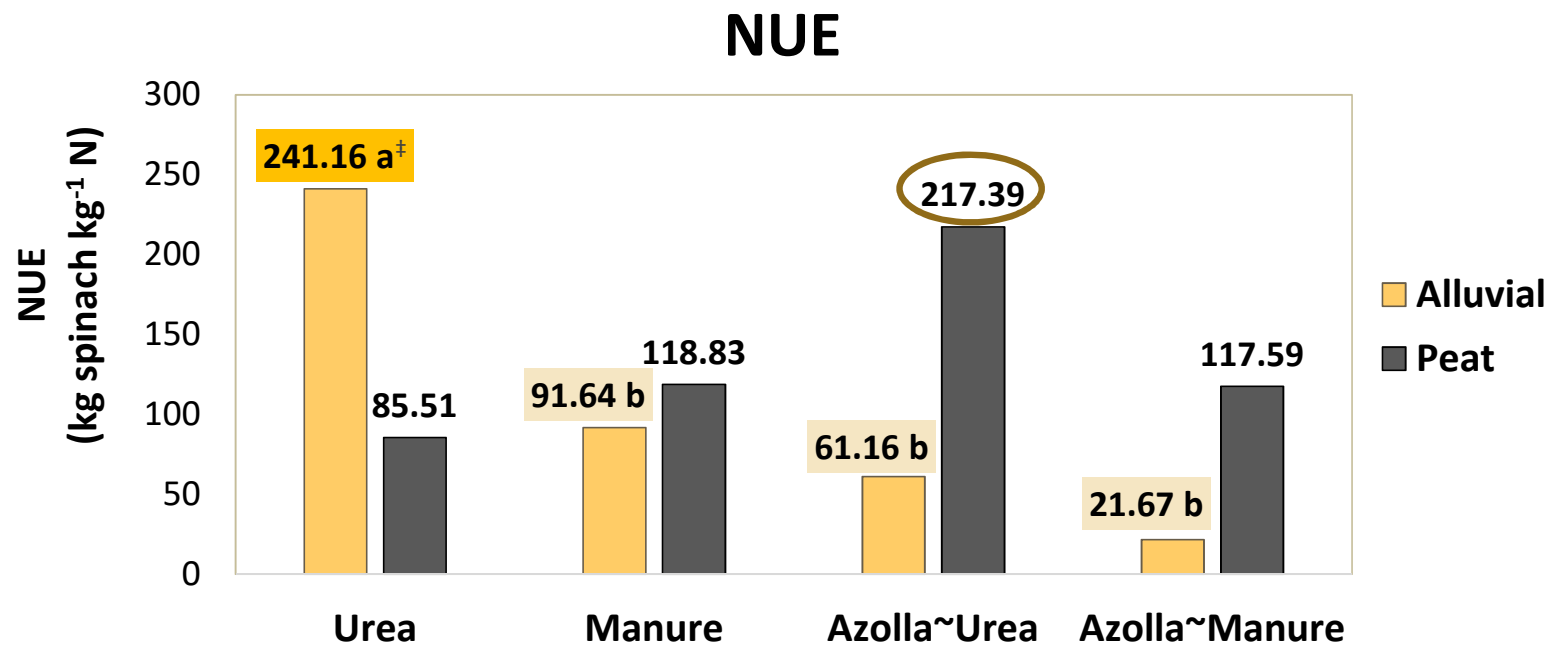
➤ Agronomic efficiency of applied N = $(Y_N - Y_0)/F_N$

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

- Sustainable Management of Agricultural Research and Technology Disseminations (SMARTD)-Indonesian Agency for Agricultural Research and Development (IAARD)-Ministry of Agriculture, Republic of Indonesia
- Colorado Agricultural Experiment Station and the Cyanobacterial biofertilizer team-Colorado State University, Fort Collins, CO, USA
- Agricultural Research Station team in Sei Kakap and Assessment Institute for Agricultural Technology of West Kalimantan, Indonesia
- Subroto-local farmer in Siantan, West Kalimantan, Indonesia

Thank You

