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Tropical Forages

Phenotyping of *Urochloa humidicola* hybrids for its BNI potential, biomass production, forage quality and N_2O Emissions

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CIAT: Three breeding programs in Tropical Grasses

Dr. Valheria Castiblanco

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Interspecific - *Urochloa decumbens / brizantha / ruziziensis*
1990

Robust, tolerant to low fertility.

Characteristics to be improved: Spittlebug resistance, persistence, seed production and abiotic stress.

Urochloa humidicola
2010

Robust, tolerant to low fertility, tolerant to watterlogging and high BNI.

Characteristics to be improved: Nutritional quality, spittlebug resistance, seed production, abiotic stress.

Panicum maximum
2016

High quality and biomass production. Double purpose forage and high BNI.

Characteristics to be improved: Abiotic stress.

Urochloa humidicola program: Recurrent Selection

CIAT (Sexual) × CIAT 26149 (Apomictic) cv "Tupi"

Sexuals (14 genotypes)

x

Apomictic ACC (21 genotypes)

Uh08 population

Sexuals

Apomictic

High biological nitrification inhibition and biomass

- [BNI, CIAT-16888 (Subbarao et al. 2009)]
- Cv. "Antioqueña" (ICA 2017)

High waterlogging tolerance

- CIAT-6570, CIAT-6013, CIAT-6133 and CIAT-679 (Cardoso et al. 2013, 2014)]

Spittlebug tolerance

- CIAT-6133 [previously identify as *B. dictyoneura* (Fig. & De Not.) Stapf]
- "Llanero" cultivar (ICA 1987)

First synthetic population of tetraploid sexuals in *U. humidicola* CIAT's hybrid breeding for Recurrent Selection

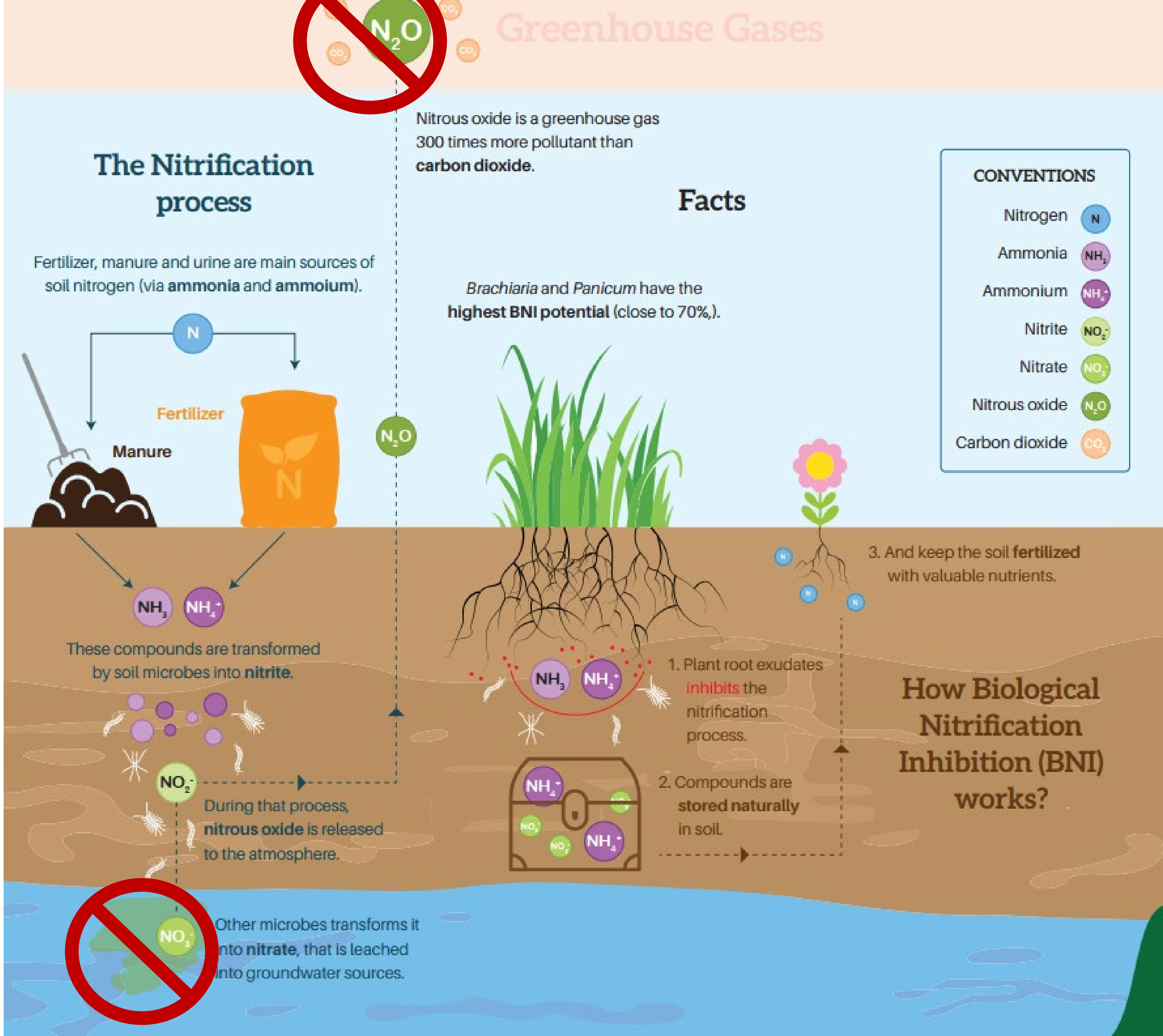
Why Inhibit Nitrification?

Nitrification is one of the major causes of nitrogen loss from agricultural systems (up to 70% of the N fertilizer applied is lost to the environment)

Direct annual economic loss

$81 Billions

U.S. Dollars*



*Based on a world annual N fertilizer production of 150 million Mg, US$ 0.50 kg^{-1} urea. Source: Galloway et al., 2008.

Apomictic hybrids of *U. humidicola* (Uh) Uh08 population

Year 2012:

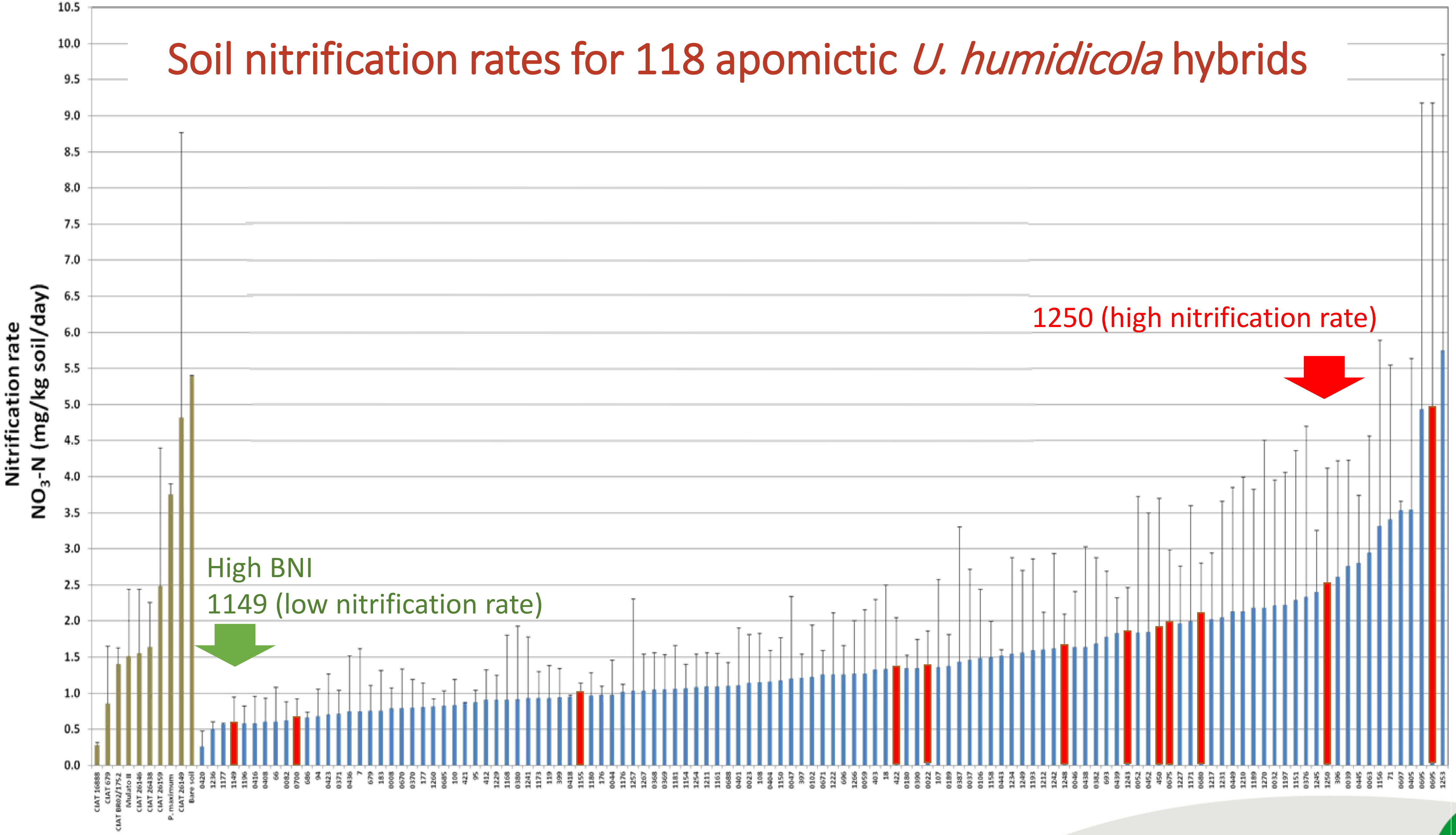
Evaluation of 118 hybrids of *U. humidicola* (Uh) for their growth and nutritive value and their potential ability to inhibit nitrification in soil under greenhouse conditions.

Objective:

To identify contrasting hybrids with different levels of BNI and the selection of a set of 12 contrasting hybrids for subsequent field evaluations.

(Pre-breeding, methodology development and potential hybrid identification)

Soil nitrification rates for 118 apomictic *U. humidicola* hybrids



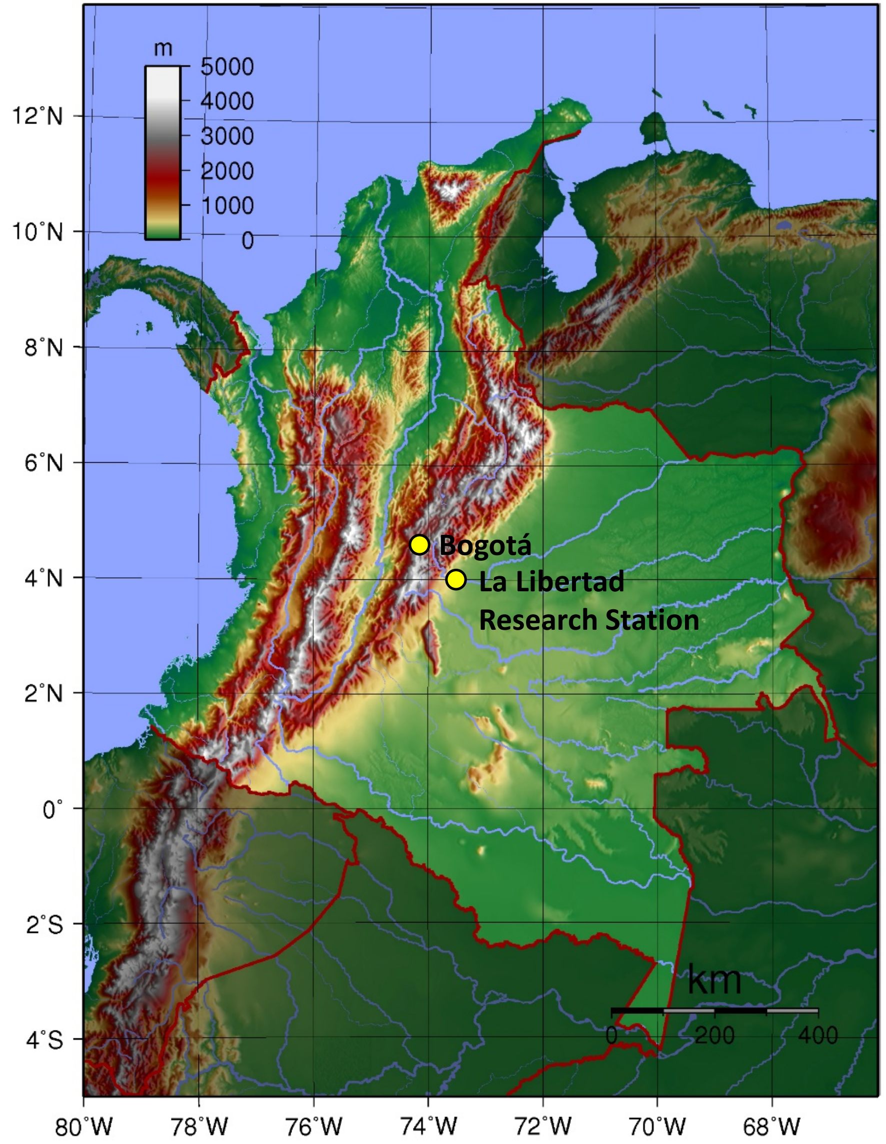
Brachiaria humidicola hybrid

Twelve contrasting *Uh* hybrids Uh08 selected for field evaluation

Uh08 hybrid
1149
450
1250
0700
696
1155
422
0680
0675
1248
1243
0022

Controls
U. humidicola CIAT 26159 (high BNI)
U. humidicola CIAT 16888 (high BNI)
U. humidicola CIAT 679 (high BNI)
U. humidicola CIAT 26146 (parental)
U. humidicola CIAT 26149 (parental)
Urochloa hybrid cv. Mulato II CIAT 36087 (low- inter. BNI)
Panicum maximum CIAT 16028 (intermediate BNI)
Bare soil: negative control (no plants)

Field evaluation 2014-2018



Study location: Agrosavia-La Libertad Research Center ("Llanos"region of Colombia)

Altitude: 336 m.a.s.l.

Annual mean temperature: 26 °C

Annual mean rainfall: 2,933 mm

Soil order: Oxisol

Soil chemical analysis (20 cm depth) of field site

pH: 4.91
OM: 30.34 g/kg
P: 14.37 mg/kg
Al: 1.30 cmol/kg
Ca: 1.10 cmol/kg

Mg: 0.38 cmol/kg
K: 0.11 cmol/kg
CEC: 2.89 cmol/kg
Al-saturation: 44.95%

Field trial

Experimental design: RCB, 3 replications

Experimental unit: 4x4 m plot

(60 experimental units in total)

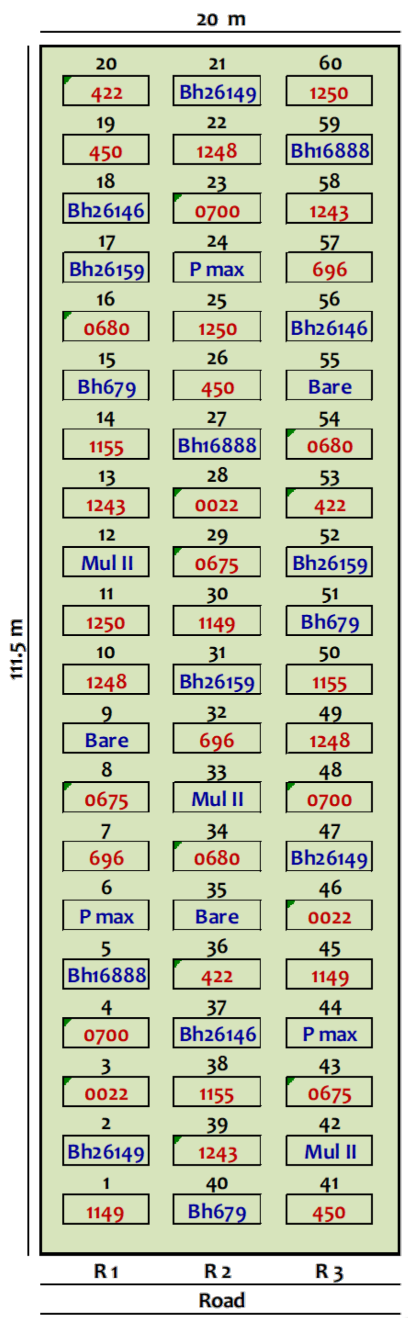
Planting density: 10,000 plants/ha

(16 plants/plot)

Planting date: August 29, 2013

Fertilizers mixture rates (Kg/ha):

100 N (urea), 25 P (DAP), 50 K (KCl), 50.5 Ca, 14.2 Mg, 10 S, 0.44 B, 0.09 Cu and 2.6 Zn.



Measurements from field evaluation 2014-2017

Wet season

Dry season

Forage yield

- Biomass production

Forage quality parameters:

- Crude protein (CP)
- In vitro dry matter digestibility (IVDMD)
- Neutral and Acid detergent fiber (NDF, ADF)

NIRS Foss 6800

Soil nitrification rates measured during the rainy season

NH_4^+
27 mM

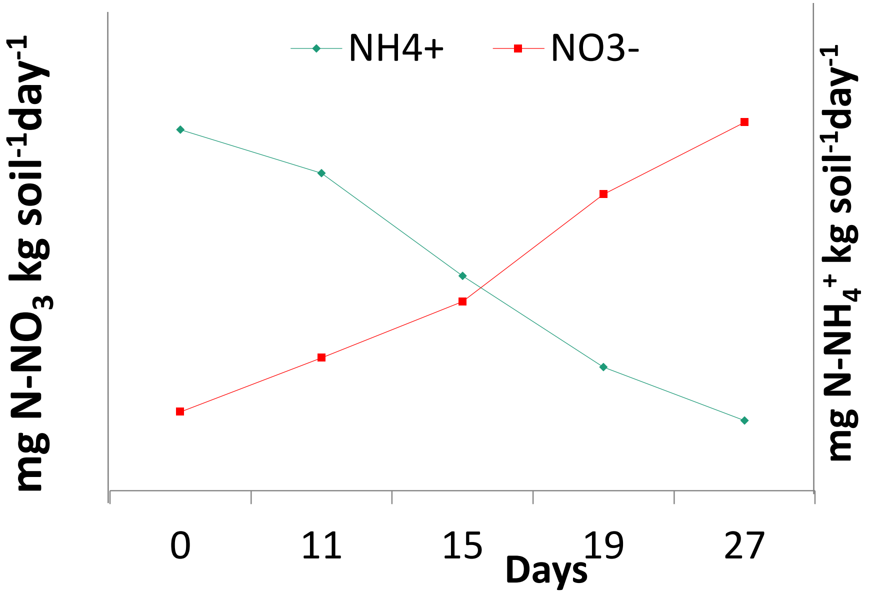
Basal N

5 g of rhizosperic soil

NH_4^+ and NO_3^- quantification

11 15 19 27 days

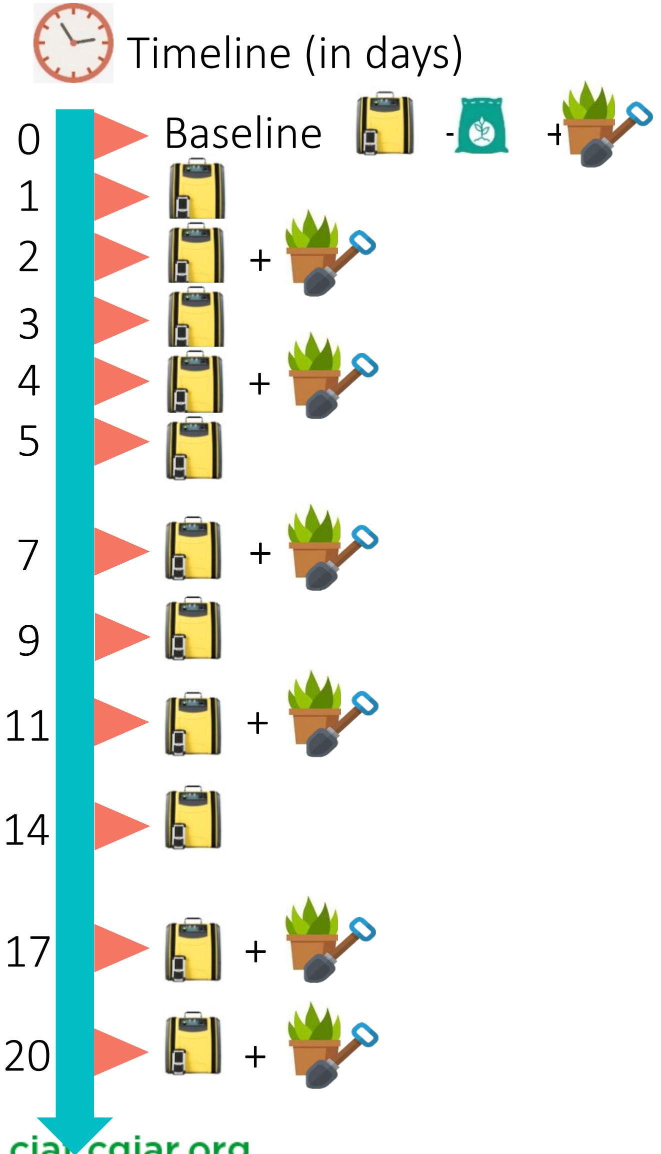
Incubation at 25°C



Nitrification rate (mg N-NO_3 kg soil^{-1} day^{-1})

High nitrification rate ~ Low BNI capacity!

Measurement of N_2O emission in the field using a portable FTIR Gas analyzer



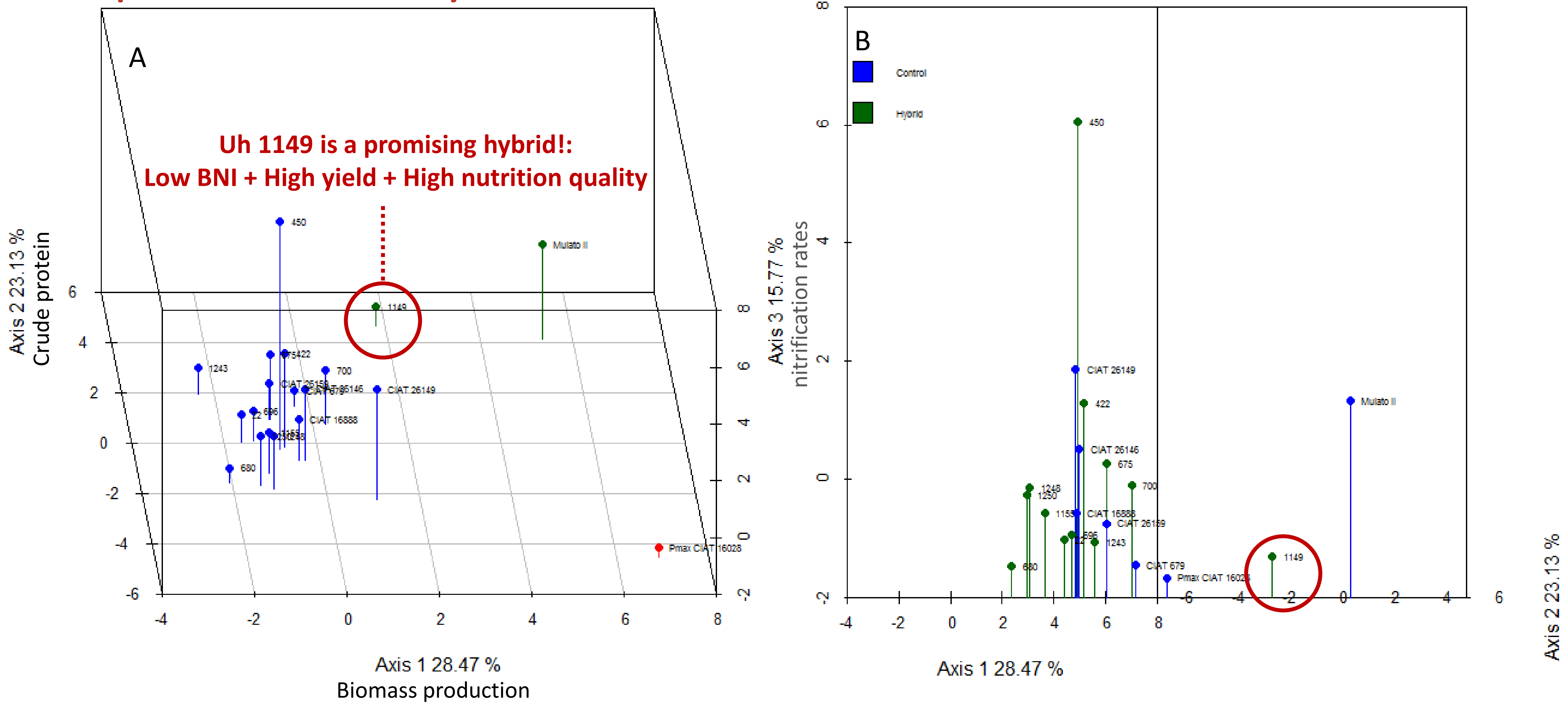
Daily measurements (per chamber)

- Soil moisture
- Soil temperature
- Nitrous oxide

2 chambers per each plot (6 chambers per genotype)

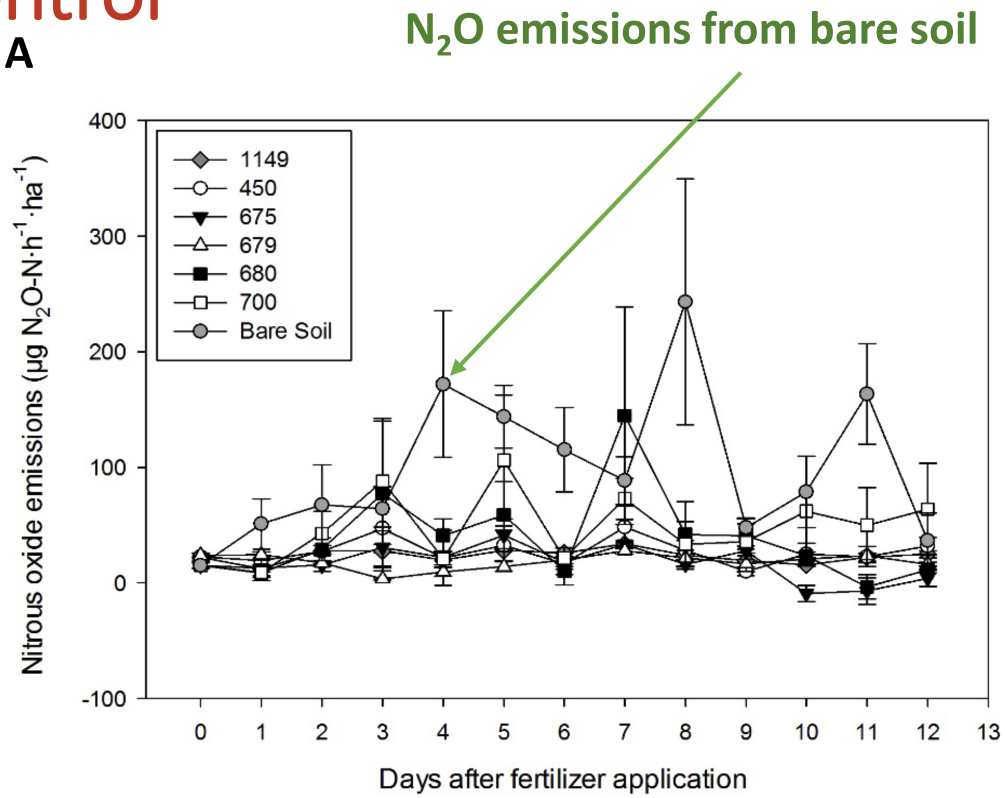
- Soil sampling each every 2 days to measure mineral nitrogen

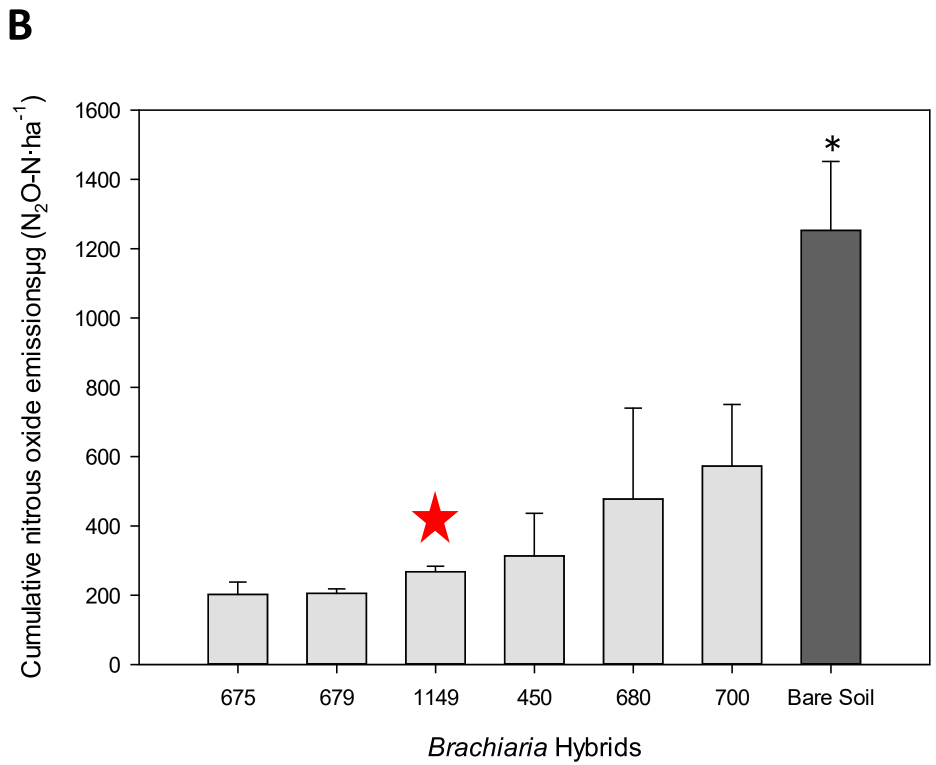
Comparison of *Uh* hybrids in the field evaluation from 2014 to 2017



3D visualization of a principal component analysis based on forage yield (Axis 1), nutrition quality-crude protein (Axis 2), nitrification rates (Axis 3) **A.** Hierarchical Cluster using PCA; **B.** Representation comparing hybrids vs control genotypes

N_2O emissions from *Urochloa* hybrids Uh08 are lower than bare soil control





N_2O emissions from *Urochloa* hybrids Uh08 (450, 675, 680, 700 and 1149) and controls Uh 679 cv. Tully (high BNI) and Bare Soil in the rainy season of 2018. **A.** N_2O emissions from *Urochloa* hybrids Uh08 during 11 days after fertilization. **B.** Bar plot showing cumulative N_2O emissions. Asterisk indicates significant difference according to Dunn test $p<0.05$

Thank you!

CIAT 50
1967-2017

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REFERENCES: Galloway JN; Townsend AR; Erisman JW; Bekunda M; Cai Z; Freney JR; Martinelli LA; Seitzinger SP; Sutton MA. Transformation of the Nitrogen Cycle: Recent Trends, Questions, and Potential Solutions. Science 320:889-892. DOI: 10.1126/science.1136674