Nitrogen use efficiency for green onion (Allium fistulosum) in sands of South Central Coastal Vietnam using 15N-labelling

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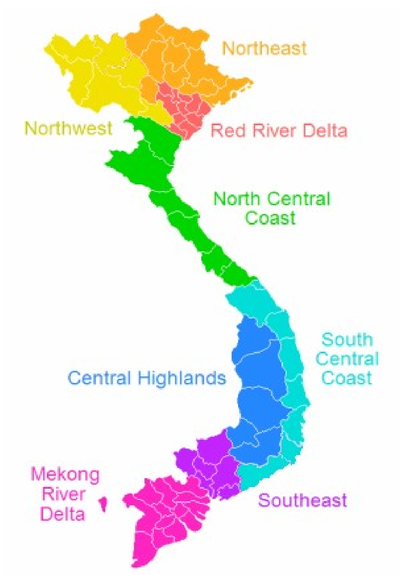
INTRODUCTION

Across the world, only 30 – 50 % of nitrogen (N) fertilizer is taken up by crops (Cassman et al., 2002). Excessive N fertilizer application will result in gaseous losses by volatilization or de-nitrification, or by leaching leading to low nitrogen use efficiency (NUE).
With high temperature, strong winds and the use of flood irrigation, NUE for vegetable production on sandy terrain in South Central Coastal Vietnam is expected to be low. Increasing NUE on sands is particularly challenging due to low nutrient storage and high percolation rate of water through the root zone.



Sandy soil in the South Central Coastal Vietnam region

MATERIALS AND METHOD

Clay-rich soil (Clay), bentonite (Ben) and sugarcane residue (SR) were chosen as amendments applied to deep sand at: 30 t of sugarcane residue ha-1, 100 t of bentonite and 300 t clay soil ha-1 (to achieve 25 g/kg clay content to 20 cm depth). They were thoroughly mixed to 20 cm depth in an Arenosol in An Hai commune, Ninh Phuoc district, Ninh Thuan province.
Onion was grown under flood and sprinkler irrigations. The 15N-labelled urea was applied to (0.6 x 1.2m) mini-plots at 134 kg N/ha and 10.16 % N atom excess.

Incorporating amendments into 20cm topsoil of sands

Onion crop with 15N-labelled mini-plot

RESULTS

Under the flood irrigation, amendments increased N uptake from fertilizer two- to threefold, while sprinkler irrigation even in the control sands doubled N uptake from fertiliser. However, only 3.8 to 19% of fertilizer nitrogen was recovered by onion crop. Sugarcane residue was most effective in increasing fertilizer N recovery, while bentonite and clay had similar but lesser effects in improving fertilizer N use on deep sand.
Soil N recovery ranged from 19.2 to 24.4 % of N fertiliser added. However, overall 63 to 73 % of N applied was lost during onion growth. For sprinkler irrigation, sugarcane residue reduced loss by 13 %, while clay and bentonite saved about 10 % of N loss compared to sand.

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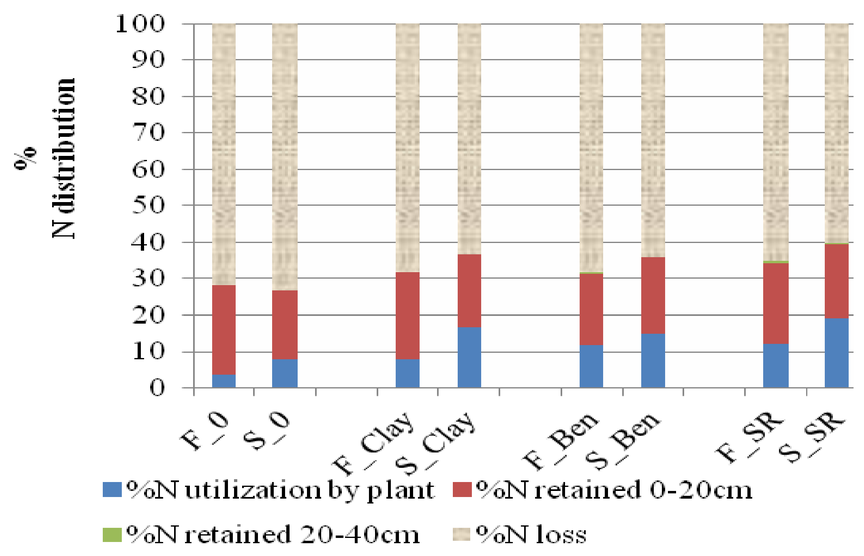
Dry matter yield and N uptake from onion crop, March to May, 2015

Amendment	Irrigation*	Dry matter yield	N uptake	N uptake from fertilizer
		kg/ha	kg/ha	kg/ha
0	F	558 d	11.6 d	5.2 e
Clay	F	940 d	20.8 d	10.4 de
Ben	F	1705 bc	33.9 bc	15.6 cd
SR	F	1506 c	32.1 c	16.1 bcd
0	S	980 d	21.0 d	10.4 de
Clay	S	2134 b	43.8 ab	*22.4 ab*
Ben	S	1879 bc	38.6 bc	*20.1 abc*
SR	S	2769 a	51.2 a	25.5 a
$LSD_{0.05}$		498	10.7	6.0

Note:* F: flood; S: sprinkler; Clay: clay-rich soil; Ben: bentonite; SR: sugarcane residue
LSD0.05=Least significant difference (p<0.05); means followed the same letter(s) within the columns do not differ significantly at p<0.05



N distribution in N soil-onion system under flood and sprinkler irrigations

F_0: unamended flood irrigation; S_0: unamended sprinkler irrigation;
F_Clay: clay soil amendment, flood irrigation; S_Clay: clay soil amendment, sprinkler irrigation;
F_SR: sugarcane residue amendment, flood irrigation; S_SR: sugarcane residue treatment, sprinkler irrigation.

CONCLUSIONS

- The amendment of sands with clay-rich soil, bentonite or sugarcane residue reduced N loss and increased both soil N retention and plant N utilization.
- Sprinkler irrigation on the sand increased fertilizer NUE.
- The fertilizer NUE even with the best combination of amendment and sprinkler irrigation was very low, and 63 73 % of fertilizer N was lost from the plant-soil system.
- Further research is needed to increase NUE on deep sands such as water use-efficient irrigation, changes in N fertilizer application method (e.g. fertigation) and rate, as well as optimal types and rates of soil amendments including combinations of clay with organic materials.

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