ウォーターフットプリントを用いた緩効性肥料の地下水への硝酸溶脱削減効果の評価

Examination of the Effectiveness of Controlled Release Fertilizer for Nitrate Leaching Reduction to Groundwater Via Water Footprint Assessment

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Introduction

Groundwater (GW) pollution by nitrate leaching from sugarcane fields is a critical issue which limits the optimum utilization of GW. Controlled release fertilizers (CRF) are used to optimize crop N use efficiency. However, CRF's impact on N leaching is not measured so far in Okinawan conditions. Thus, the study was focused on confirming the effectiveness of CRF for N leaching reduction from sugarcane fields.

Material and methods

Analysis of leached nitrate N:

A lysimeter study was conducted using four fertilizer treatments (Table 1). Underground drainage of experimental plots was collected, and water samples were analyzed for nitrate N.

Fertilizer treatment	First fertilization			Second fertilization		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	(kg/ha)			(kg/ha)		
Non-vegetation/No fertilizer application (NoF)	0	0	0	0	0	0
P and K fertilizer application without N (N-free)	0	29	42	0	29	42
Urea/Normal released fertilizer application	100	29	42	100	29	42
Controlled release fertilizer (CRF) application	200	58	83	0	0	0

Table 1. Fertilizer treatment levels used.

Water footprint (WF) assessment:

The standard procedure for WF assessment described by Hoekstra *et al.*, (2011) was used in the study. WF of sugarcane farming under urea and CRF treatments were estimated to express the impact of different fertilization practices on GW.

Results and discussion

Analysis of leached nitrate N:

Nitrate N leaching from lysimeters was highly sensitive to rainfall variability. When compare the cumulative values of two crop seasons (Figure 1), nitrate N leaching of plant cane season of all fertilizer

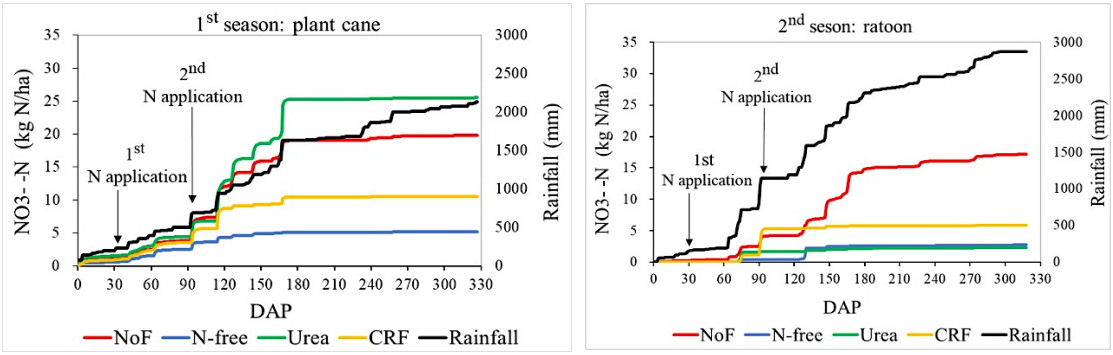

Figure 1. Cumulative nitrate-N leaching variation with rainfall

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treatments was higher than that of ratoon. According to Verburg *et al.*,, more N leaching loss can be observed from plant canes than ratoons due to extra mineralized N availability during the preceding fallow and higher drainage occurs due to higher initial water content from water stored in profile. In our study, ratoon recorded a higher dry matter yield than plant cane causing lower N leaching in ratoon season than in plant cane season for all treatments (figure 2).

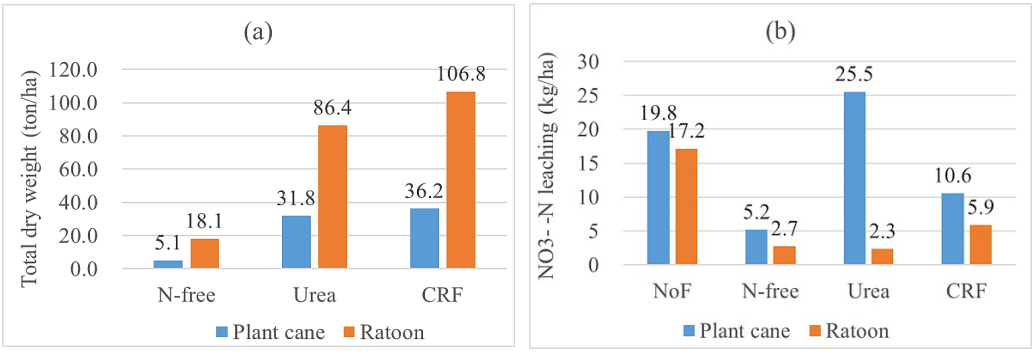

Figure 2. (a) Total sugarcane dry weight and (b) nitrate-N leaching

Analysis of growth parameters:

Sugarcane stalk height and stalk number related to CRF and urea treatments did not show any significant difference from each in both seasons. However, comparatively higher number of stalks were recorded for ratoon than plant cane indicating higher N uptake and lower nitrate-N leaching (figure 3) in ratoon season under all treatments.

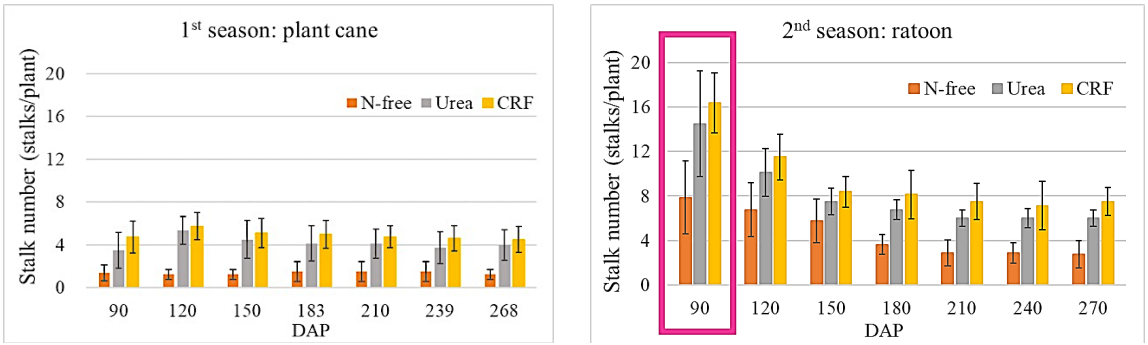

Figure 3. Variation of sugarcane stalk number for treatmetns used

WF assessment:

Sugarcane grey WF was 17.28 m^3/t and 44.99 m^3/t for CRF and Urea treatments respectively in plant cane season. For ratoon season sugarcane grey WF was 5.79 m^3/t for CRF and 2.93 m^3/t for Urea treatment. Total sugarcane WF was 192.33 m^3/t for CRF and 233.47 m^3/t for Urea application for plant cane season. For ratoon, total WF was 190.47 m^3/t for CRF and 237.59 m^3/t for Urea treatment. Obtained WF values indicated the lower impact of CRF application on GW than Urea application.

Conclusions

In terms of achieving sustainable, realistic sugarcane yields while ensuring GW conservation, CRF is a positive alternative for urea.

Key References

Hoekstra, A. Y. *et al.* (2011) *The Water Footprint Assessment Manual. Setting the Global Standard*, *Water Footprint Network 2011 All*. Longdon, Washington, DC: Earthscan.

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