Intergeneric hybrid between sugarcane and *Erianthus* exhibits superior nitrogen use efficiency than sugarcane

Nitrate-nitrogen leaching from farmland has adverse effects on drinking water and environmental conservation in tropical and subtropical island regions such as the Southwest Islands of Japan. Sugarcane is widely grown in these areas, and it is necessary to increase the nitrogen use efficiency of this crop to reduce nitrogen leaching. Studies on nitrogen utilization in this species have focused on yield potential and fertilizer management; however, there have been only a few breeding attempts. The relationship between root system characteristics and nitrogen utilization is also unclear, while improvement of nitrogen utilization using *Erianthus arundinaceus* can be expected because of its unique root system characteristics. In the present study, nitrogen leaching and root system characteristics of sugarcane × *Erianthus* intergeneric hybrid and parental genotypes were investigated using a lysimeter to verify the possibility of improving nitrogen utilization characteristics.

Nitrogen leaching was significantly lower under the parental *Erianthus* from the early growth stage, while it was significantly lower in the intergeneric hybrid in the mid-growth stage than that in the parental sugarcane. The nitrogen use efficiencies of *Erianthus* and the intergeneric hybrid were significantly greater than that of sugarcane. *Erianthus* and the intergeneric hybrid exhibited lower shoot/root ratio and deeper rooting than sugarcane and consumed significant amounts of soil moisture in the deeper layers, suggesting that root mass and deeper rooting may be factors in reducing nitrogen leaching. These results indicate the possibility of improving the nitrogen utilization characteristics of sugarcane by improving its root system characteristics using *Erianthus*.

The intergeneric hybrid F_1 can be used to breed sugarcane varieties that contribute to reductions of nitrogen leaching and fertilization. However, it is necessary to improve the sugar content of the F_1 line through backcrossing with sugarcane varieties in order to utilize it as a variety for sugar production because the F_1 line has low sugar content at harvest season. In addition to root elongation characteristics, nitrate preference may also be related to greater nitrogen use efficiency, which should be investigated in future studies using the N^{15} tracer method.

(H. Takaragawa, K. Okamoto, Y. Terajima, T. Anzai)

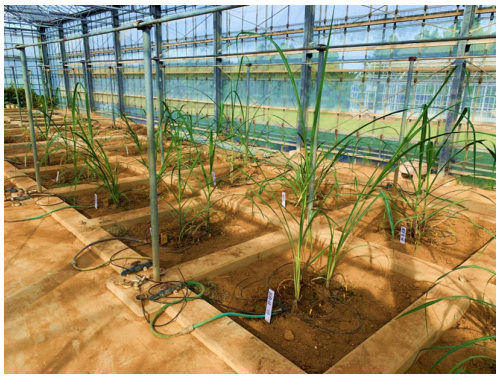

Fig. 1. Outline of lysimeter study
Sugarcane (NiF8), *Erianthus* (JIRCAS1), and intergeneric hybrid F_1 (J08-12) were grown under lysimeter conditions (n=4 plots) from Sept. 2020 to May 2021.

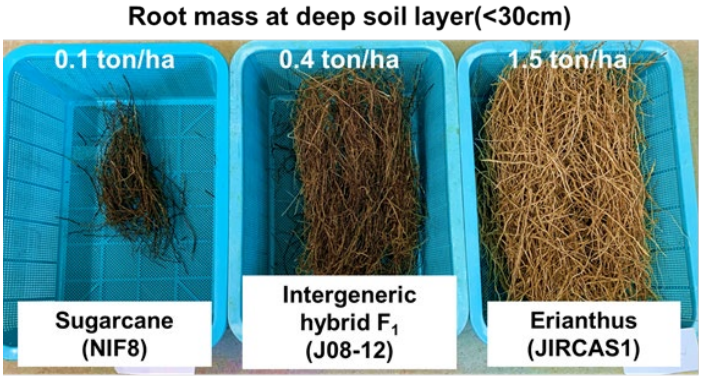

Fig. 2. Root mass of each genotype
Values indicate root mass at deep soil layer with significant genotypic differences.

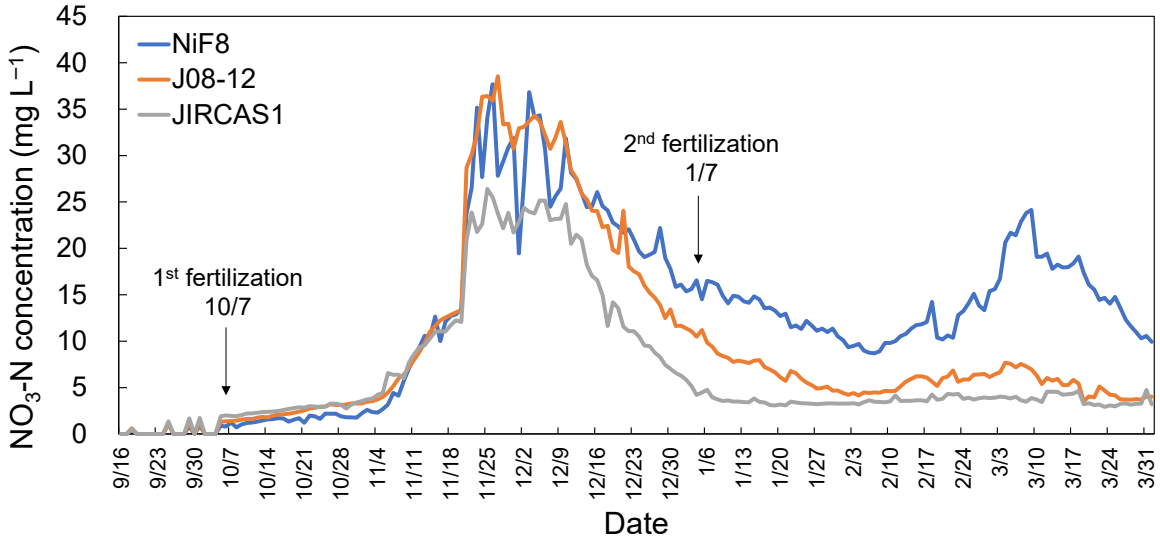

Fig. 3. Changes in nitrate-nitrogen concentration in drainage water during the growth period
Survey was conducted from September 2020 to March 2021. Arrows indicate fertilization dates.

Table 1. Characteristics of nitrogen use and biomass partition

Genotype	Drainage NO^3-N (kg ha^{-1})	Total dry mass (ton ha^{-1})	Shoot mass/ Root mass ratio	Root depth index (cm)	Total N uptake (kg ha^{-1})	N use efficiency (g gN^{-1})
Sugarcane (NiF8)	42.6 b	17.0 a	30.7 c	24.8 a	104.5 a	163.5 a
Intergeneric hybrid F_1 (J08-12)	32.4 b	27.6 b	24.8 b	31.6 b	136.3 b	202.4 b
Erianthus (JIRCAS1)	17.8 a	26.4 b	6.4 a	35.7 b	128.3 ab	206.7 b

Higher root depth index indicates deeper root system. Nitrogen use efficiency is calculated by dividing total biomass by total nitrogen uptake. Different alphabet means significant differences among genotypes at $P < 0.05$ (Tukey, n=4).

Reference: Takaragawa et al. (2022) *Plant Production Science* 25: 298–310.