Intergeneric hybrid between sugarcane and *Erianthus* exhibits superior leaf water-use efficiency compared to sugarcane

Erianthus arundinaceus, a closely related genus to sugarcane (*Saccharum* spp.), is expected to contribute to improving sugarcane's drought tolerance through interspecific hybridization. So far, JIRCAS has reported *Erianthus* traits associated with drought tolerance, including excellent root system development, leaf gas exchange characteristics (water use efficiency; WUE—calculated by dividing photosynthetic rate by stomatal conductance, a measure of transpiration), and metabolite adaptations. While reports exist on the root system development of intergeneric hybrids between sugarcane and *Erianthus*, there are no reports on the leaf characteristics (gas exchange and morphological traits) of their hybrids, and the potential for improving sugarcane leaf characteristics through intergeneric hybridization remains unclear.

We investigated the leaf gas exchange characteristics, morphological traits, and dry matter allocation patterns of a sugarcane variety (NiF8), an *Erianthus* accession (JW630), and an intergeneric F_1 hybrid (J16-77 [NiF8 x JW630]) derived from these parents under pot conditions at JIRCAS-TARF, to verify the potential for improving these traits through intergeneric hybridization. Although the difference was not significant under high-light conditions, *Erianthus* showed higher WUE than that of sugarcane regardless of soil moisture conditions (Fig. 1). Genotypic differences in WUE became more pronounced under low-light conditions (photosynthetic photon flux density of 500 μmol m^{-2} s^{-1}) compared to high-light conditions (2,000 μmol m^{-2} s^{-1}) during gas exchange measurements (Fig. 1). Compared to sugarcane, *Erianthus* has a lower stomatal density on the abaxial side of the leaves, a higher ratio of adaxial to abaxial stomatal density, and longer interveinal distances (Table 1). These differences are largely due to genetic factors. Sugarcane allocates a large proportion of dry matter to the stem, whereas *Erianthus* allocates more to the leaves and roots (Fig. 2). The WUE and stomatal density of the F_1 hybrid are comparable or close to those of the *Erianthus* parent (Fig. 1, Table 1). On the other hand, the F_1 hybrid shows a large proportion of dry matter allocation to the stem similar to that of the sugarcane parent (Fig. 2).

Through intergeneric hybridization, it is possible to develop hybrids that inherit leaf characteristics from the *Erianthus* parent and dry matter allocation to the stem from the sugarcane parent, thereby combining the characteristics of both parents. The F_1 hybrid possesses desirable above-ground traits which may contribute to improving sugarcane drought tolerance, although further field studies will be required. Because the tested F_1 hybrid has low sugar content at harvest, improving sugar content through backcrossing with sugarcane varieties is necessary for their utilization as breeding materials.

Authors: Takaragawa, H., Terajima, Y., Okamoto, K. [JIRCAS]

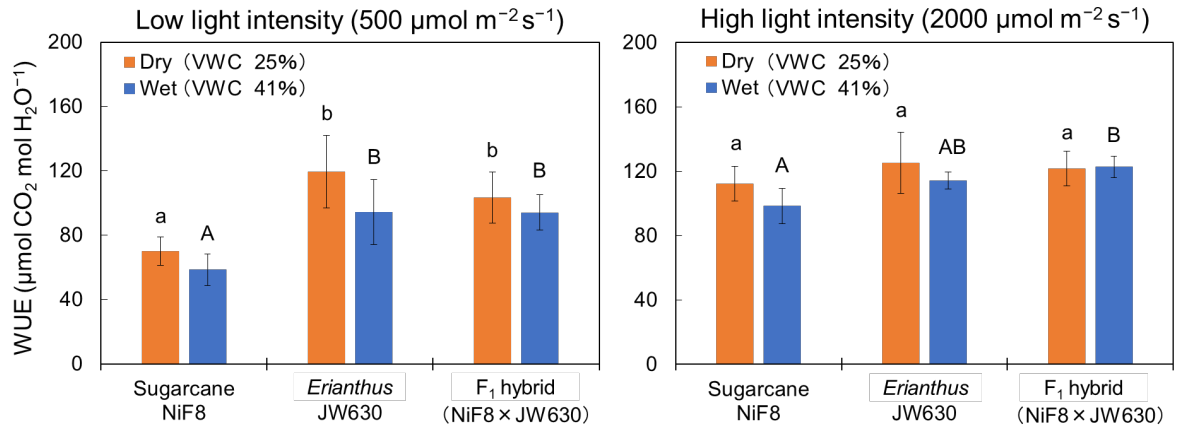

Fig. 1. Effects of soil moisture and light intensity on water use efficiency (WUE) in sugarcane, *Erianthus*, and intergeneric F_1 hybrid

The results measured on Sep. 26, 2021, during the soil drying treatment, under low-light (photosynthetic photon flux density 500 μmol m^{-2} s^{-1}; left panel) and high-light (2,000 μmol m^{-2} s^{-1}; right panel) conditions are shown. The orange and blue bars represent data from the dry (soil volumetric water content; VWC 25%) and the wet (41%) treatments, respectively. Error bars indicate standard deviation (n = 4). Different letters indicate differences among treatment groups within the same light intensity × soil moisture condition (Tukey's test, $p < 0.05$, n = 4).

Table. 1. Leaf morphological characteristics in sugarcane, *Erianthus*, and intergeneric F_1 Hybrid

Treatment	Genotype	Stomatal density (no. mm^{-2})			Interveinal distance (μm)
		Adaxial	Abaxial	Ad/Ab	
Wet	Sugarcane NiF8	93 a	178 b	0.52 a	123 a
	Erianthus JW630	98 a	135 a	0.73 c	140 b
	F_1 hybrid (NiF8 x JW630)	99 a	148 a	0.67 b	152 b
Dry	Sugarcane NiF8	94 A	177 C	0.53 A	129 A
	Erianthus JW630	100 AB	138 A	0.72 B	147 B
	F_1 hybrid (NiF8 x JW630)	106 B	160 B	0.66 B	154 B

Different letters indicate significant differences between genotypes within each treatment (Tukey's test, $p < 0.05$, n = 4).

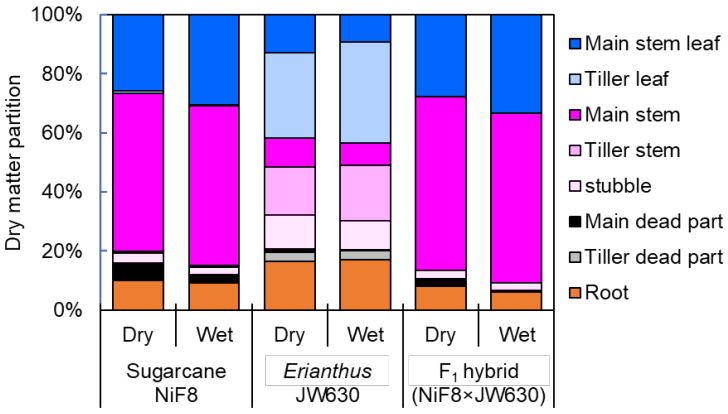

Fig. 2. Biomass partition in sugarcane, *Erianthus*, and intergeneric F_1 hybrid

The dry matter partition indicates the percentage of dry matter in each plant part relative to the total dry matter weight. Sugarcane and intergeneric hybrid exhibit similar dry matter allocation characteristics, such as a high dry matter allocation ratio to the stem.

Reference: Takaragawa et al. (2025) *Frontiers in Plant Science* 16: 1649112. © Authors 2025
The figures and table are modified from Takaragawa et al. (2025).