Improvement of sugarcane root characteristics through intergeneric hybridization between sugarcane and *Erianthus*

In order to improve crop productivity and sustainable production under climate change, crops that are tolerant to drought stresses need to be developed. Improving root characteristics is an important breeding target to increase the productivity of crops grown under drought conditions. In sugarcane (*Saccharum* spp. hybrid), an important crop for global food and energy production, there is concern about increasing drought damage and a need to improve drought tolerance through root improvement. However, there have been few reports on root improvement in sugarcane, and the limitations of improvement using existing breeding materials have been pointed out. *Erianthus arundinaceus*, a genetic resource of a closely related genus of sugarcane, has large and deeply developed roots, making it highly adaptable to drought. Its roots also show high deposition of lignin, which is one of the major components of plant cell walls and is also associated with drought stress tolerance. Therefore, it has great potential to be a promising breeding material for improving the root characteristics of sugarcane. This study evaluated the root characteristics of an intergeneric F_1 hybrid of sugarcane and *E. arundinaceus* to assess the potential for introducing the root characteristics of *E. arundinaceus* into sugarcane through intergeneric hybridization.

Field experiments were carried out at the Japan International Research Center for Agricultural Sciences using the sugarcane cultivar NiF8, *E. arundinaceus* clones, and their intergeneric F_1 hybrid J08-12. We evaluated root distribution from 0 to 120 cm depth and fiber composition. J08-12 and *E. arundinaceus* clones had greater root dry weight per stool and smaller shoot-root ratios than NiF8. Regarding root distribution, J08-12 and *E. arundinaceus* clones had significantly greater root dry weights and root length densities than NiF8 in the deep soil layers. Root lignin contents were low in NiF8, high in *E. arundinaceus* clones, and intermediate in J08-12. These results indicate that intergeneric hybridization of sugarcane and *E. arundinaceus* could successfully introduce root characteristics of *E. arundinaceus*, such as deep root distribution and high lignin content, into sugarcane. Improving sugarcane root characteristics through intergeneric hybridization with *E. arundinaceus* will be a powerful strategy to improve drought tolerance and achieve sustainable sugarcane production in the future.

Authors: Terajima, Y., Sugimoto, A., Takagi, H., Ando, S. [JIRCAS],
Tippayawat, A. [Khon Kaen Field Crops Research Center],
Irei, S. [Okinawa Prefectural Agricultural Research Center],
Hayashi, H. [Univ. of Tsukuba]

Table 1. Agronomic traits and root characteristics of the intergeneric F_1 hybrid J08-12

Experiment	Clone	Dry matter yield (t ha^{-1})	Stalk number (stalks ha^{-1})	Root dry weight (g stool^{-1})	Shoot-root ratio	Lignin content (mg g^{-1}-DW)
Exp. 1	J08-12	31.9 ns[1)]	131,305 *	80 ns	18 *	163 ns
	NiF8	20.3	63,161	24	35	140
	IJ76-349	58.8 *	117,041 *	251 *	10 *	193 *
	JW630	46.1 *	552,315 *	170 *	12 *	228 *
Exp. 2	J08-12	31.6 ns	145,688 ns	65 ns	26 ns	166 *
	NiF8	27.3	100,714	42	30	133
	JIRCAS1	51.7 *	588,810 *	214 *	16 *	199 *

* and n.s. indicate significant differences at P < 0.05 and no significant difference from NiF8, respectively, according to the Dunnett test. Exp. 1 is the mean of three years of data harvested in January 2011, January 2012, and December 2012. Exp. 2 is the mean of two years of data harvested in January 2014 and February 2015. NiF8 is the sugarcane cultivar. IJ76-349, JW630, and JIRCAS1 are *Erianthus* clones. J08-12 is an intergeneric F_1 hybrid between NiF8 and JIRCAS1.

Table 2. Root length density of J08-12 at different soil depths (cm cm^{-3})

Experiment	Clone	Soil depth					
		0-20 cm	20-40 cm	40-60 cm	60-80 cm	80-100 cm	100-120 cm
Exp. 1	J08-12	1.07 ns[1)]	0.49 ns	0.41 *	0.30 ns	0.23 ns	0.24 *
	NiF8	0.85	0.61	0.20	0.11	0.08	0.04
	IJ76-349	3.18 *	1.20 *	0.66 *	0.30 ns	0.34 *	0.37 *
	JW630	3.03 *	1.31 *	0.62 *	0.33 ns	0.31 *	0.26 *
Exp. 2	J08-12	1.55 ns	0.61 ns	0.53 ns	0.45 *	0.29 *	0.21 *
	NiF8	1.28	0.55	0.36	0.18	0.09	0.04
	JIRCAS1	2.53 ns	1.09 ns	0.65 ns	0.56 *	0.32 *	0.32 *

* and n.s. indicate significant differences at P > 0.05 and no significant difference from NiF8, respectively, according to the Dunnett test. Exp. 1 evaluated the root of the second ratoon crops, which was harvested in January 2011, January 2012, and December 2012. Exp. 2 evaluated the root of the first ratoon crop, harvested in January 2014 and February 2015.

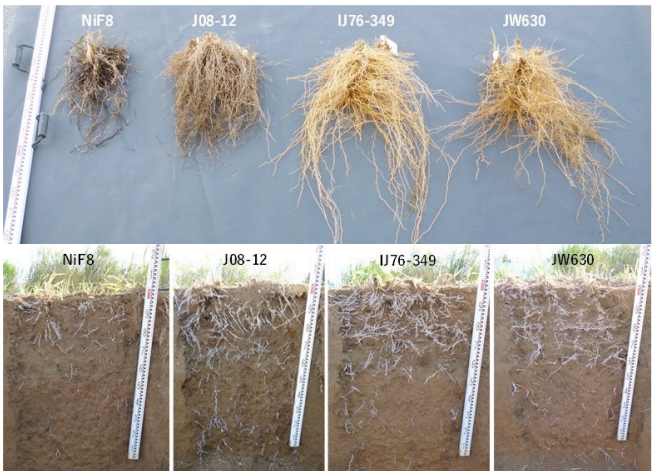

Fig. 1. Amount (top) and distribution (bottom) of roots of J08-12

J08-12 has more roots and deeper root distribution than NiF8 (Exp. 1).

Reference: Terajima et al. (2023) *Field Crops Research* 297: 108920.
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