New sugarcane varieties using wild sugarcane and collaboratively bred in Thailand

Along with an increasing world population, tight food and energy supplies have become a problem. In areas where agricultural productivity is low, urgent measures are required to increase crop productivity in the fields and to enhance food and energy production. Sugarcane was among those identified as important candidate crops because it can produce food and energy from its sugar and fiber. Therefore, we tried to develop new sugarcane varieties that provide high yields of both sugar and fiber in Northeast Thailand, where sugarcane productivity is low because of severe drought, infertile soil, and sugarcane white leaf disease. Sugar is a food component and can also be a source of bio-ethanol, whereas electricity can be generated from bagasse, a byproduct of sugarcane fiber.

Interspecific hybridization between commercial cultivars of sugarcane and *Saccharum spontaneum* (wild sugarcane) clones, which were collected from all over Thailand, was carried out and F_1 populations were obtained. F_1 hybrids were crossed with commercial cultivars of sugarcane and BC_1 populations were obtained. From the BC_1 population, TPJ03-452, TPJ04-713, and TPJ04-768 were selected and registered as new varieties of sugarcane by the Department of Agriculture, Thailand on February 5, 2015 (Table 1). The sugar yields of TPJ03-452 and TPJ04-768 were at a comparable level with those of commercial cultivars, Khonkaen3 and K88-92, but the fiber yields were higher than those of Khonkaen3 and K88-92. Total fiber yield of TPJ03-452 in three years was about 1.9 times more than that of Khonkaen3 and total fiber yield of TPJ04-768 in two years was about 1.6 times more than that of Khonkaen3 (Table 2). Cane yield, sugar yield, and fiber yield of the first ratoon cane of Khonkaen3 decreased a lot from those of the planting cane but in the case of TPJ04-768, the decrease was less than those by Khonkaen3 (Table 2). TPJ03-452 and TPJ04-768 had thinner stalks and higher fiber content than Khonkaen3 and K88-92. TPJ04-768 had longer stalks than Khonkaen3 (Table 3 and Fig. 1).

Ratooning is a labor-saving and a low cost method of cultivating sugarcane. TPJ04-768 can produce sugar at a comparable level to commercial cultivars, and the decrease of cane yield from the planting cane to the ratoon cane is small. Multiple ratoon cultivation of this variety is expected in Northeast Thailand, which has a long and severe dry season. It will be supplied to farmers and sugar mills for field tests in order to become a recommended variety. A harvester will be needed because the stalks are thin and the leaves are difficult to remove. However, unlike commercial cultivars, these new varieties have high fiber content, thus new methods may need to be developed to produce sugar and ethanol.

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Table 1. History of new sugarcane varieties

Name of variety	Mother plant	Father plant
TPJ03-452	Uthong1	F_1 interspecific hybrid (K84-200 x *S. spontaneum*)
TPJ04-713	CP72-5028	F_1 interspecific hybrid (88-2-401 x *S. spontaneum*)
TPJ04-768	94-2-128	F_1 interspecific hybrid (88-2-401 x *S. spontaneum*)

Except for *S. spontaneum*, names of commercial cultivars or lines are indicated.

Table 2. Millable cane yield, sugar yield, and fiber yield of new sugarcane varieties per hectare

Name of variety	Millable cane yield (t/ha)			Sugar yield (t/ha)			Fiber yield (t/ha)		
	1st year	2nd year	3rd year	1st year	2nd year	3rd year	1st year	2nd year	3rd year
TPJ03-452	105.1	76.0 (72)	58.7 (56) a	10.7	10.4 (97)	4.6 (43) a	19.7	12.1 (62)	9.4 (48) a
Khonkaen3	91.4	64.9 (71)	36.5 (40) a	13.2	9.7 (73)	4.4 (33) a	10.8	7.8 (72)	3.4 (32) b
K88-92	92.9	58.9 (63)	39.0 (42) a	10.9	7.9 (73)	4.0 (37) a	9.7	5.5 (56)	3.6 (37) b
TPJ04-713	76.8	77.2 (101)	a	6.6	6.8 (103)	a	9.6	9.3 (97)	ab
TPJ04-768	77.1	79.5 (103)	a	8.9	10.1 (113)	a	13.3	11.9 (89)	a
Khonkaen3	84.0	61.9 (74)	a	12.2	8.6 (70)	a	8.8	7.0 (80)	b

Results at the Tha Phra branch of Khon Kaen Field Crops Research Center (KKFCRC) are shown in the upper table. Sugarcane was planted in March 2008 with two replications; the planting cane of the first year was harvested in February 2009, the first ratoon cane of the second year was harvested in January 2010, and the second ratoon cane of the third year was harvested in December 2010. Results at the KKFCRC were shown in the lower table. Sugarcane was planted in May 2013 with four replications; the planting cane of the first year was harvested in March 2014, and the first ratoon cane of the second year was harvested in March 2015. Sugar yield (Commercial cane sugar (CCS) yield) = millable cane yield x CCS (%) /100. CCS (%): % of calculated recoverable sugar from millable cane. Fiber yield = millable cane yield x fiber content (%) /100. Figure in parentheses indicates the relative yield of the second or the third year to the yield of the first year. The varieties with same letter in the column are not significantly different according to the Tukey's method at P = 0.05 in two-way analysis of variance among varieties and years.

Table 3. Characteristics of new sugarcane varieties

Name of variety	No. of millable cane (/ha)	Length of millable cane (cm)	Diameter of millable cane (cm)	Brix (%)	CCS (%)	Fiber (%)
TPJ03-452	66026 a	293 a	2.18 c	20.4 a	13.9 a	15.8 a
Khonkaen3	61058 a	172 a	2.62 b	23.2 a	14.4 a	12.2 ab
K88-92	49519 a	223 a	3.13 a	19.5 a	13.5 a	9.3 b
TPJ04-713	62179 a	269 b	2.63 a	17.5 b	9.0 b	12.1 b
TPJ04-768	51282 ab	342 a	2.22 b	22.4 a	12.7 a	15.0 a
Khonkaen3	42468 b	240 b	2.84 a	22.9 a	14.0 a	11.3 b

Results at the harvest of the first ratoon cane of the second year in the field experiments of Table 2 are shown in Table 3. Brix (%): weight % of soluble matter. CCS (%): % of calculated recoverable sugar from millable cane. The varieties with same letter in the column are not significantly different according to the Tukey's method at P = 0.05 in one-way analysis of variance.

Fig. 1. TPJ03-452 (left) and TPJ04-768 (right) planting canes. Photos taken in October 2013.