Sweet Sorghum Varieties for Total Soluble Sugar and Grains under Tarlac Conditions

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Abstract

Sweet sorghum has high potential as an alternative source of bio-ethanol and feed for livestock. This study was undertaken to test sweet sorghum varieties for total soluble sugar and grain production; determine their agronomic characteristics in relation to total fermentable sugar; and to recommend varieties that are suitable for total soluble sugar and grain production. Five sweet sorghum varieties were tested during the dry season under the Tarlac Agricultural Universitys experimental area condition including NTJ 2, ICSR 93034, SPV 422, ICSV 93046, and ICSV 700. Results revealed that NTJ 2, ICSR 93034, and SPV 422 flowered and matured earlier. These varieties had bigger seed size and higher grain yield than ICSV 93046 and ICSV 700. Hence, they are promising varieties for grain production. Higher stalk and stripped yield, stalk juice yield, volume, and sugar content were also obtained from ICSV 93046 and ICSV 700 compared to the other varieties tested. Hence, these said varieties promising for total soluble sugar production in Tarlac.

Keywords: sweet sorghum, total soluble sugar, stalk yield, stripped stalk yield, sugar content

Introduction

The Philippines imports billions worth of crude oil and petroleum products annually. This is why the country calls for alternative raw materials that are environment- friendly and cost effective in sustaining the bio-fuel energy supply system.

Sweet sorghum is a C4 crop with high photosynthetic efficiency and accumulates high concentrations of easily fermentable sugars (glucose, fructose, and sucrose) in the stalks. Hence, it is widely believed that it is an alternate energy source that is renewable, sustainable, efficient, cost-effective, convenient, and safe to use. Sucrose, on the other hand, is the major sugar found in sweet sorghum juice which constitutes up to 85% of the total sugars (Woods, 2000). Sweet sorghum juices sugar content range from 10 to 25 Brix % at maturity (Reddy, et al., 2007). Its juice can also be used for the production of jaggery, syrup, and the bagasse (leftover stalks after juice extraction) that, in turn, can be used for cogeneration of power, animal fodder, and as material for organic fertilizer. Sweet sorghum is a crop close to sugarcane with respect to its sucrose accumulation and the juicy nature of the stem that offers an excellent alternative feedstock. It has many characteristics such as wide adaptability; tolerance to abiotic stresses like drought, waterlogging, salinity, and alkalinity; and the capacity to grow quickly and also to accumulate sugars in stalks (Hill, et.al, 1990). In addition, sweet sorghum has been identified as a particularly promising complementary crop for diversification of sugarcane croplands. Meanwhile, ethanol yields of 4.8 g per 100 g of fresh stalks have been obtained from soluble sugars, in expressed juice, along with additional production from the residual non-soluble material of 5.1 g of ethanol per 100 g of fresh stalks (Mamma et al., 1995). Hence, sugar yield from the said crop is the desirable characteristic for ethanol production.

Dual-type sorghum varieties have the advantage over sugarcane. Sweet sorghum matures earlier (100 days) than sugarcane (300-330 days). Moreover, the multiple uses of sweet sorghum offer wider range of market opportunities. Sweet sorghum is best suited for ethanol production because of its higher reducing sugar content com-

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pared to other sources. Sorghum can also be ratooned so that multi-harvest is done for one single planting. Sweet sorghum has been successfully grown in many parts of the world, especially in the semi-arid tropics. It has a wide adaptability and is relatively tolerant to drought, waterlogging, soil salinity and acidity stresses, and it requires low inputs to attain good yields (ICRISAT, 2006). Sweet sorghum also has a very high biomass for ethanol production for both traditional fermentation, as well as, cellulose fermentation. According to ICRISAT (2006), producing ethanol from sweet sorghum is lower than that from molasses. It provides a grain yield of 2-6 tons/ha and its stillage has a higher forage value (rich in micronutrients and minerals) than the bagasse of sugarcane. Since sorghum grain is the staple food grain in several parts of India, further improvement in grain yield was done to get a dual-purpose crop giving high yields of grain and stem biomass. To form this dual purpose crop, crossing was carried out between lines having high stalk yields, high Brix of juice with property of retention of juiciness of stalk after grain maturity, and lines giving high yield of pearly white grain as one of the parents. This said corssing resulted in production of sweet sorghum varieties capable of high yields of grain with acceptable quality and possessing juicy stalks high in sugar content (Ravjansvi and Nimbkar, 2000).

Varieties/restorer lines bred earlier at ICRISAT were screened for millable cane yield and stalk sugar content., The varieties that were recommended were ICSV 700 and ICSR 93034. Eight of the promising lines were tested in the Philippines through experiments at MMSU, Batac, Ilocos Norte. NTJ 2, SPV 422, ICSV 700 and, ICSR 94034 were found to be promising multi-purpose (grain, stover, green fodder, and juicy sweet stalk) varieties with high biomass production ability. Sorghum seed crop matures in 100-110 days after sowing while the ratoon crop matures in 85-95 days. The grain yield is 3.28-3.62 t/ha for the seed crop and 3.92-4.0 t/ha for the ratoon crop (Layaoen and Remolacio, 2006).

Sweet sorghum can be raised in dry areas with minimum water available. Based on ICRISAT data, sweet sorghum will survive with a supply of less than 300 mm of water over the season. Typically, sweet sorghum needs between 500 to 1,000 mm of water (rain and/or irrigation) to achieve good yields of 50 to 70 t/ha total above ground biomass (fresh weight). Sweet sorghum can be grown in areas where the accumulated temperature (over 10 °C) 26-45°C. It grows well in black clay loam soils (PCAARRD, 2007).

Promising lines have been developed by ICRISAT, however, these have to be tested and evaluated in a wide range of environmental conditions. Varieties that performed best will be adopted for commercial production.

This study aimed to test the adaptability and to evaluate sweet sorghum varieties for grains and total soluble sugar production; determine their post-harvest characteristics; and identify and recommend varieties that are suitable for total soluble sugar and grain production under Tarlac condition.

Methodology

An area of 12.5m x 11 m that was located at the Tarlac Agricultural Universitys Experimental Area (Station) was used in the conduct of the study in three dry planting seasons from 2007-2010. The area was prepared thoroughly by two plowings/rotavations and harrowings. Furrows were made at 1 m apart. Soil samples were also collected before planting and after harvest for the soils chemical determination. Meteorological data on temperature and rainfall that prevailed during the duration of the study were requested from the PAGASA Weather Station based at the said university.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. Each plot measured 5 m long and 5 m wide with 5 rows spaced 1 m apart. An alleyway of 1.5 m was provided between replications. Five sweet sorghum varieties such as NTJ 2, ICSR 93034, SPV 422, ICSV 93046 and ICSV 700 were evaluated serving as treatments.

Prior to planting, fertilizers were applied at the rate of 100-60-100 kg NPK/ha using 14-14-14 and Muriate of potash. The fertilizer materials were covered with 2- cm soil before planting.

After fertilizer application, the seeds were drilled in the furrows at the rate of 30 seeds per linear meter. The seeds were also covered with

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2-3 cm thick fine soil. Irrigation was done by furrow method just after seed sowing. Succeeding irrigation was once more carried out one week after seedling emergence and every two weeks thereafter up to grain filling stage. Thinning and replanting were done two weeks after planting, this left only 15 plants per linear meter. Manual weeding was done two weeks after planting to remove weeds that may compete with the plants for nutrients and which could serve as alternate hosts of insect pests. One month after planting, hilling-up was done to cover the nitrogen fertilizer applied at the base of the plants. Weeding was continued until before the closing of the canopy.

Furthermore, grain harvesting was done when 40% or more of the grains have turned pearly white by cutting the panicles from the stalk. This was followed by harvesting from the sampling area, 3.0 m x 3.0 m (9.0 sq m, 3 rows). Afterwards, panicles were sun dried and threshed. After threshing, the grains were sun dried for three days. Stalks (including the leaves) were cut from the base of the plant and weighed to get the stalk yield. Leaves were removed from the stalks (stripped stalks) and weighed to get the stripped stalk yield. Stripped stalks were then crushed using the crushing machine/mill to obtain the juice. The weight and volume of the juice were recorded. In addition, the sugar content of the juice was determined using a hand-held refractometer to determine the Total Soluble Solid (TSS) at degree Brix (°Brix).

All the data gathered were analyzed using the Analysis of Variance of the Randomized Complete Block Design (RCBD) and treatment means were compared using the Duncans Multiple Range Test (DMRT).

Results and Discussion

Site Characterization and Agro-Climatic Conditions

Physical and Chemical Characteristics of the Soil

Composite soil samples were collected in the experimental area before planting for physical and chemical characterization of the soil. The soil is clay in texture with a pH of 6.2 to 6.4. Under TAU conditions, % OM and available P were low to sufficient while exchangeable K was sufficient.

Table 1. Physical and Chemical Characteristics of the Soil Before Planting

	Planting Season		
	2007	**2008**	**2009**
Texture	Clay	Clay	Clay
pH	6.4	6.2	6.2
% OM	Low	Low	Low
Available P (ppm)	Medium	Medium	Low
Exchangeable K (me/100g soil)	Sufficient	Sufficient	Sufficient

Meteorological Data

The rainfall and temperature data that prevailed during the entire growing season of the plants were obtained from the TAU-PAGASA Agrometeorological Station (Tables 2, 3 and 4). The highest maximum temperature (37.4 °C) was experienced in April 2010 (Table 4) and highest minimum temperature (27.1 °C) was noted in April 2008 (Table 2).

Growth conditions were characterized by high rainfall during the vegetative growth of the plants in 2007-2008 trial (Table 2). However, in succeeding trials from 2008-2010, low rainfall was observed (Tables 3 and 4). Total rainfalls received during the trials were 733.40 mm for 2007-2008, 8.01 mm for 2008-2009, and 10.39 mm for 2009-2010 trial.

Agronomic Characteristics

Plant Height (cm)

For 2007-2008 trial, ICSV 700 was the tallest plant followed by ICSV 93046. While for 2008-2009 trial, ICSV 93046 and ICSV 700 were taller than NTJ 2, ICSR 93034, and SPV 422. And lastl, for 2009-2010 trial, ICSV 700 and ICSV 903046 were the tallest plants among the varieties evaluated.

The observed differences in plant height were due to inherent varietal characteristics. ICSV 700 and ICSV 93046 are genetically taller than NTJ 2, ICSR 93034, and SPV 422. Under ICRISAT conditions, these varieties grow as high 200-300 cm for early maturing varieties and 300-320 cm

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Table 2. Monthly Mean Temperature during the 2007-2008 Planting Season

Year/Month	Mean Temperature (°C)		Mean Rainfall (mm)
	Maximum	Minimum	
2007			
September	33	26.3	176.4
October	33.7	25.1	209
November	31.3	26.4	219.6
December	32.1	24	4.2
2008			
January	32.1	24.6	20.6
February	31.9	24.8	14.6
March	33.4	35.8	41.2
April	25.3	27.1	47.8
TOTAL			733.4

Table 3. Monthly Mean Temperature during the 2008-2009 Planting Season

Year/Month	Mean Temperature (°C)		Mean Rainfall (mm)
	Maximum	Minimum	
2008			
November	32.7	23.4	3.5
December	32.4	22.2	1
2009			
January	31.1	21.6	0.05
February	33.5	23	0.2
March	35.4	23	0.06
April	35.2	24.2	3.2
TOTAL			8.01

Table 4. Monthly Mean Temperature during the 2009-2010 Planting Season

Year/Month	Mean Temperature (°C)		Mean Rainfall (mm)
	Maximum	Minimum	
2009			
October	31.5	23.1	9.1
November	32.3	21.2	1.1
December	32.3	21.2	0.05
2010			
January	31.6	21.2	0.11
February	35.6	22.9	0
March	31.4	24.6	0.02
April	37.4	24	0.01
TOTAL			10.39

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for late maturing varieties depending on the season (ICRISAT, 2006).

Stalk Diameter (cm)

No significant differences were noted on stalk diameter during the 2007-2008 trial that ranged from 1.45 to 1.48 cm. However, during the 2008-2009 trial, ICSV 93046, ICSR 93034, and NTJ 2 had bigger stalk diameter than the other varieties. During the 2009-2010 trial, ICSV 93046 had the biggest stalk diameter among the different varieties tested. Differences in stalk diameter could be due to inherent traits of the varieties used.

Panicle Length (cm)

For 2007-2008 trial, ICSR 93034 and NTJ2 developed the longest panicles followed by SPV 422 and ICSV 93046. On the other hand, the shortest panicle was developed by ICSV 700. In addition, for 2008-2009 trial, ICSR 93034, NTJ 2, and SPV 422 developed longer panicles than ICSV 93046 and ICSV 700. Finally, for 2009-2010 trial, ICSR 93034 and NTJ 2 had the longest panicles followed by SPV 422; while the shortest panicles were developed by ICSV 93046 and ICSV 700. Differences in panicle length can be attributed to inherent varietal characteristics.

Number of Days to Flowering

Highly significant differences in the number of days to flowering were noted among the different varieties of tested sorghum. NTJ 2 flowered the earliest in 56 to 64 days after planting which was similar to ICSR 93034 and SPV 422. The latest to flower were ICSV 93046 and ICSV 700 which took 68 to 97 days after planting. The same trend was observed in all the three trials conducted. Differences in the number of days to flowering could be due to varietal differences among the different varieties tested. It could be noted that the five varieties flowered earlier under Philippine conditions than under ICRISAT, India conditions with flowering dates from 80-115 days after sowing. Early flowering could also be due to the prevailing favorable conditions that increased the rate of physiological processes such as photosynthesis and respiration and thus, hastened the onset of the reproductive phase of sweet sorghum (see climatic data).

Number of Days to Maturity

In all the trials conducted, the different varieties differed significantly in terms of number of days to maturity. NTJ 2, ICSV 93034, and SPV 422 matured earlier that took 96 to 102 days after planting as compared to ICSV 700 and ICSV 93046 that matured in 113 to 121 days after planting. The different varieties tested were observed to mature earlier under Philippines conditions than those grown under ICRISAT, India conditions that matured from 120- 130 days after sowing (ICRISAT, 2006).

Yield and Yield Components

Stalk Yield (t/ha)

Highly significant differences existed among the different varieties evaluated in terms of stalk yield per hectare (Table 6). ICSV 700 and ICSV 93046 had higher stalk yields than the other varieties tested. For 2008-2009 trial, ICSV 93046 had the highest stalk yield. During the 2009-2010 trial, ICSV 93046 and ICSV 700 obtained higher yield than NTJ 2, ICSR 93034, and SPV 422. Moreover, ICSV 93046 and ICSV 700 are tall and produced big diameter of stalks that might have contributed to higher stalk yield.

Stripped Stalk Yield (tons/ha)

The stripped stalk yield of the different varieties differed significantly in all the trials conducted (Table 6). ICSV 93046 had the highest stripped stalk yield during the 2007-2008 trial. Furthermore, for the 2008-2009 trial, ICSV 93046 once again obtained the highest stripped stalk yield. While for the 2009-2010 trial, ICSV 93046 and ICSV 700 obtained the highest stripped stalk.. Higher stripped stalk yield obtained by ICSV 93046 and ICSV 700 could be attributed to longer and bigger diameter of stalks developed.

Stillage Yield (t/ha)

Highest stillage yield was obtained from the late maturing variety, ICSV 93046 during the

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Table 5. Agronomic Characteristics of Five Sweet Sorghum Varieties tested from 2007-2010 Dry Season Planting

Varieties	Plant Height (cm)			Stalk Diameter (cm)			Panicle Length (cm)			Number of Days to Flower			Number of Days to Maturity		
	Planting Season														
	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010
NTJ 2	257.62 c	268.13 b	257.25 c	1.46	1.81 a	1.62 bc	23.84 a	24.08 a	21.63 ab	56.00 a	64.00 a	59.00 a	98.00 a	97.00 a	102.00 a
ICSR 93034	265.58 c	272.68 b	276.60 bc	1.48	1.87 a	1.64 b	24.56 a	24.13 a	22.83 a	57.00 a	66.00 b	61.00 b	97.00 a	97.00 a	103.00 a
SPV 422	264.70 c	280.60 b	286.43 b	1.45	1.66 b	1.58 bc	21.48 b	23.90 a	20.70 b	58.00 a	65.00 ab	62.005 b	97.00 a	96.00 a	103.00 a
ICSV 700	348.90 a	379.28 a	318.18 a	1.47	1.54 c	1.52 c	21.12 bc	19.54 b	17.04 c	71.00 b	97.00 c	68.00 c	14.00 b	122.00 b	116.00 b
ICSV 93046	316.44 b	384.18 a	339.55 a	1.48	1.92 a	1.75 a	19.06 c	20.26 b	17.24 c	72.00 b	96.00 c	69.00 c	13.00 b	122.00 b	116.00 b
ANOVA	**	**	**	ns	**	**	**	**	**	**	**	**	**	**	**
cv (%)	4.2	3.1	4.8	6.5	4.3	4	4.9	6.4	8	1.6	1.3	1.8	0.5	0.3	0.4

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2007-2008 and 2008-2009 trials respectively (Table 6) and followed by ICSV 700 for both years of testing. However, during the 2009-2010 trial, ICSV 700 and ICSV 93046 got higher stillage yield than NTJ 2, ICSR 93034, and SPV 422. The lowest stillage yield was obtained by NTJ 2, ICSR 93034, and SPV 422.

Weight of 100 Seeds (g)

The five varieties of sweet sorghum differed significantly in terms of seed size (Table 6). For 2007-2008 trial, ICSR 93034 and NTJ 2 had heavier seed weight than the other varieties tested. Meanwhile, for 2008-2009 trial, NTJ 2, SPV 422, and ICSR 93034 obtained heavier seed weight than the late maturing varieties. Finally, for 2009-2010 trial, the early maturing varieties and ICSV 93046 had heavier seed weight than ICSV 700. Differences in seed weight could be due to varietal differences in terms of seed weight. Under ICRISAT conditions, 100 seeds weigh from 3.0 to 3.8 g (ICRISAT, 2006) that are comparable to the seeds produced in the Philippines.

Grain Yield (t/ha)

The said t varieties differed significantly in terms of grain yield (Table 6). ICSR 93034, SPV 422, and NTJ 2produced higher grain yield than ICSV 93046 and ICSV 700. NTJ 2, ICSR 93034, and SPV 422 have longer panicles and heavier seed weight than ICSV 93046 and ICSV 700 that had contributed to higher grain yield. Bird damage was a problem during the study that reduced grain yield of the varieties tested.

Postharvest Characteristics

Stalk Juice Volume (kli/ha)

Highly significant differences were noted on the juice volume produced by the varieties tested (Table 7). ICSV 93046 and ICSV 700 had produced the highest volume of juice during the 2007-2008 trial. During the 2008-2009 and 2009-2010 trials, ICSV 93046 produced the highest juice volume than the other varieties tested. The lowest juice volume was obtained from NTJ 2, ICSR 93034, and SPV 422. Higher stalk and stripped yields in ICSV 93046 resulted to higher stalk juice volume produced.

Stalk Juice Yield (t/ha)

More juice were obtained from the stalks of ICSV 93046 and ICSV 700 during the 2007-2008 trial (Table 7). On the other hand, for the 2008-2009 and 2009-2010 trials, ICSV 93046 consistently obtained higher stalk juice yield than the other varieties tested. This was followed by ICSV 700. Meanwhile, NTJ 2, ICSR 93034, and SPV 422 obtained the lowest juice yield. It was also observed that ICSV 93046 had obtained higher stripped stalk yield that had contributed to higher stalk juice yield. In addition, more juice can be extracted from those with higher stripped stalk yield. It should be noted that plants with bigger stems had higher stripped stalk yield which resulted in the production of more juice yield.

Sugar Content (°Brix)

For 2007-2008 trial, ICSV 93046 had the highest sugar content among the different varieties tested and the lowest was obtained by NTJ 2 (Table 7). However, for 2008-2009 trial, ICSV 93046 and ICSV 700 had higher sugar content than NTJ 2, ICSR 93034, and SPV 422. Again, during the 2009-2010 trial, ICSV 93046 had the highest sugar content that was comparable to the sugar content of ICSV 700. Differences in sugar content could be due to the inherent traits of the varieties used. Juice from ICSV 93046 and ICSV 700 were also sweeter compared to the juice of NTJ 2, ICSR 93034, and SPV 422 (ICRISAT, 2006). The brix reading for ICSV 93046 fell within the brix readings under ICRISAT conditions which ranged from 15 to 19%. This result is also comparable to the sugar content of sweet sorghum grown at MMSU, Batac, Ilocos Norte which ranged from 15 to 19% (Layaoen and Remolacio, 2006).

Conclusions

ICSV 93046 and ICV 700 were taller than NTJ 2, ICSR 93034, and SPV 422. Moreover, ICSV 93046 had bigger diameter than the other varieties tested. NTJ 2, ICSR 93034, and SPV 422

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Table 6. Yield and Yield Components of Five Sweet Sorghum Varieties tested from 2007-2010 Dry Season Planting

Varieties	Stalk Yield (t/ha)			Stripped Stalk Yield (t/ha)			Stillage Yield (t/ha)			Weight of 100 Seeds (g)			Grain Yield (t/ha)		
	Planting Season														
	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010
NTJ 2	41.92 b	60.37 c	40.96 b	34.26 b	48.28 c	36.83 b	19.75 c	28.86 c	19.52 b	3.34 ab	3.70 a	3.25 a	6.72 a	10.39 ab	7.54 a
ICSR 93034	44.72 b	65.78 c	44.32 b	36.32 b	54.35 c	39.80 b	20.87 c	31.32 c	21.86 b	3.62 a	3.53 a	3.35 a	7.05 a	11.22 a	7.61 a
SPV 422	45.04 b	64.54 c	46.96 b	37.54 b	54.74 c	42.56 b	21.13 c	32.34 c	23.28 b	3.24 bc	3.60 a	3.20 a	6.92 a	12.36 a	7.30 a
ICSV 700	63.84 a	76.71 b	58.94 a	56.44 a	68.14 b	55.19 a	27.59 b	41.52 b	32.58 a	2.60 d	2.93 b	2.60 b	4.87 b	6.57 c	5.47 ab
ICSV 93046	62.23 a	95.41 a	68.07 a	58.58 a	85.32 a	63.45 a	31.71 a	48.48 a	31.42 a	3.00 c	2.63 b	3.05 a	3.16 c	9.10 b	4.51 b
ANOVA	**	**	**	**	**	**	**	**	**	**	**	**	*	**	**
cv (%)	6.8	8.9	14.8	5.6	9.3	14.96	9.3	10	11.5	6.6	8.6	7.8	12.9	12.9	20.2

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Table 7. Postharvest Characteristics of Five Sweet Sorghum Varieties tested from 2007-2010 Dry Season Planting

Varieties	Stalk Juice Volume (kli/ha)			Salk Juice Yield (t/ha)			Sugar Content (°BRIX)		
	Planting Season								
	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010	2007-2008	2008-2009	2009-2010
NTJ 2	14.04 b	16.72 c	11.88 c	13.48 c	15.61 c	12.22 c	7.72 d	14.80 b	11.07 c
ICSR 93034	14.53 b	18.36 c	13.89 c	14.01 bc	19.46 c	14.25 c	10.34 c	14.50 b	11.82 c
SPV 422	15.94 b	18.63 c	16.14 bc	15.32 b	18.09 c	16.81 bc	9.98 c	15.95 b	12.52 bc
ICSV 700	21.55 a	22.65 b	20.42 b	22.50 a	24.46 b	21.18 b	14.90 b	17.93 a	14.22 ab
ICSV 93046	21.82 a	30.18 a	26.14 a	22.51 a	32.43 a	26.89 a	17.86 a	19.45 a	15.53 a
ANOVA	**	**	**	**	**	**	**	**	**
cv (%)	8.8	8.7	15.9	6.7	12.2	16.7	11	6.4	9.5

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had longer panicles than the other two varieties tested. In addition, NTJ 2, ICSR 93034, and SPV 422 flowered and matured earlier than ICSV 93046 and ICSV 700.

Furthermore, ICSV 93046 and ICSV 700 were found to be superior over NTJ 2, ICSR 93034, and SPV 422 in terms of stalk, stripped and stillage yields.

Meanwhile, NTJ 2, ICSR 93024, and SPV 422 had heavier seed weight and grain yield per hectare than ICSV 93046 and ICSV 700. Hence, these are promising varieties for grain production.

Finally, SV 93046 and ICSV 700 produce higher juice volume, yield, and sugar content than NTJ 2, ICSR 93034, and SPV 422. These are therefore, promising varieties for total soluble sugar production in Tarlac.

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