International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

IDENTIFICATION OF PLANTING, HARVESTING AND WATER REGIME OF SOME SUGARCANE VARIETIES (*Saccharum officinarum* L.) IN CÔTE D'IVOIRE

Marcos ZADI[*1], Louise TURQUIN[1], Crépin Bi PENE[2]

[1]Plant Physiology Laboratory, Félix HOUPHOUËT-BOIGNY University
22 BP 582 Abidjan 22, Côte d'Ivoire

[2]Research and Development Department, SUCAFCI-SOMDIAA,
01 BP1967 Abidjan 01, Côte d'Ivoire

*Corresponding author

ABSTRACT

The objective of this study was to select high performing sugarcane varieties under the bioclimatic conditions of Côte d'Ivoire. Twelve varieties of sugarcane, including three controls, were tested in randomized six-repetition complete block devices, under irrigation at the beginning and end of the season, and also under severe rain conditions. Varieties were characterized using 6 technological criteria and 7 agro-morphological criteria. The variety R579 with 115.2 tc/ha and 10.5 tse/ha was best than controls Nco376 (86.3 tc/ha and 8.0 tse/ha) and Co449 (91.6 tc/ha and 8.3 tse/ha) in irrigated conditions at the beginning of the season. At the end of the season, R579 (111.7 tc/ha and 10.7 tse/ha) is better than the controls Co449 (85.1 tc/ha and 8.2 tse/ha) and Co957 (95.6 tc/ha and 8.8 tse/ha). Under strict rainfall conditions, R579 (79.6 tc/ha and 9.5 tse/ha outperforms controls NCo376 (72.3 tc/ha and 8.0 tse/ha) and Co957 (70.6 tc/ha and 8, 3 tse/ha). These results show that the R579 variety can be developed both in village plantations under strict rainfall conditions and in irrigated farms at the beginning and end of the season.

Keywords: sugarcane, Côte d'Ivoire, smut, varietal selection, water regime, yield

INTRODUCTION

Grown primarily for the production of sugar and ethanol in the world's tropical and subtropical regions, sugarcane plays an important role in the global economy [1]. Thus, its impact on the economy is significant [2]. The sugarcane belongs to the Poaceae family, the Andropogoneae tribe and the Saccharum genus. Current cultivars are the result of interspecific crosses between S.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

officinarum, a high sugar species, and S. spontaneum, which combines vigor and resistance to several pests as well as abiotic stresses [3,4]. To improve their economic competitiveness and sustain the sugar sector, agro-industries regularly develop new varieties with high-performance in sugar. To this end, many sugar companies conduct locally varietals creation programs adapted to their needs [5]. Varietal improvement ensures sustainable agriculture by using genetic diversity and interactions between the plant, its pathogens and its environment [6]. This biotechnology is a privileged way to increase the sustainability and viability of agricultural production in a context of biotic, abiotic and socio-economic constraints. In addition, it contributes to the ecological intensification of production and helps to cope increasing competitiveness in the markets [7]. Côte d'Ivoire, like sevral African sugarcane producers countries, does not create varieties. Varietal improvement efforts in this plant are focused on the selection of varieties introduced via international quarantines [8]. These imported varieties are designed to have high cane, sugar yields, to be tolerant to the major diseases of the cane and for their energy uses. However, considering the well known genotype x environment interaction in sugarcane [9,10,11], it is important to conduct a behavioral study of introduced varieties in Côte d'Ivoire for a better assessement of their performance in irrigated conditions, at the beginning or end of the season or in rainfall conditions. The purpose of this study is to identify the agricultural context that allows optimal expression of the genetic potential of twelve imported varieties of sugar cane.

MATERIAL AND METHODS

The plant material used is consisted of twelve varieties including three controls (Co449, NCo376 and Co957) and nine imported (R83/176, TUC7216, TUC7215, R579, FR90/831, PS59 SP79/1230, SP75/184, SP71/8210.

Experimental Design

Varieties of this study were tested under irrigation:

- at the beginning of cropping season;

- at the end of cropping season;

And in rainfall conditions at the beginning of cropping season.

Each test was set up using a randomized complete block device with 6 repetitions. The elementary plots of the blocks consisted of 8 lines of 10 m (120 m²), for a total surface of 7 200 m² per test. The NCo376, Co449 and Co957 varieties already present in Côte d'Ivoire were used as controls in all three trials (table 1).

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

Table 1: Varieties tested in the three trials conducted in Ferkéssédougou, Côte d'Ivoire

Varieties	Agro-climatic situations		
	Irrigation begining	**Irrigation, end**	**rainfalll**
Tested	R83/176	TUC7216	SP79/1230
	TUC7216	FR90/831	SP75/184
	TUC7215	PS59	SP71/8210
	R579	R579	R579
Controls	**Co449 et NCo376**	**Co449 et Co957**	**NCo376 et Co957**

Evaluation of sugar cane technological quality

Sampling canes

For each varietal trial, the technological parameters of each elementary plots were measured in the saccharimetry laboratory on a primary sample of 10 stems at their physiological maturity taken shortly before harvest. Each of the stem corresponding to a given elementary parcel is divided into 3 parts. A secondary sample of 10 reconstituted stems is formed per plot to ensure homogeneity of the primary sample.

Cultivation conditions

The planting of sugarcane in single rows (1.5 m of spacing) was done manually, as was the cutting and bucking of the stalk. The technical itinerary was as follows: glyphosate treatment of the previous cane culture, pre-irrigation, soil spraying, ridging, manual fertilization of the NPK ternary fertilizer in the furrows, planting of the cuttings, pre-emergent herbicide , weeding at 4-5 and 7-8 months, manual harvesting at 12 months after burning. Fertilization was carried out manually by providing 120 kg N / ha, 46 kg P2O5 / ha, 180 kg K2O / ha at virgin, on the one hand, and 130 kg N / ha, 79 kg P2O5 / ha and 213 kg K2O / ha in regrowth, on the other hand. In the rainfall trial, the soil was first de-compacted, pulverized and furrowed before planting the cuttings manually. Weed control was ensured by weeding or herbicidization (ametryne-atrazyne + 2.4 D). Contribution of mineral elements was made by adding N, P, K (16, 8, 23). In the regrowth, the recommended cultural practices included, after the previous harvest, pre-emergent hexazinone mechanized herbicide, manual weeding at 4-5 months, NPK fertilization (600 kg/ha), manual harvesting at 11- 12 months.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

Evaluation of sugar cane technological quality

Sampling of sugar canes

For each varietal trial, the technological parameters of each elementary plots were measured in the saccharimetry laboratory on a primary sample of 10 stems at their physiological maturity taken shortly before harvest. Each of the stem corresponding to a given elementary parcel is divided into 3 parts. A secondary sample of 10 reconstituted stems is formed per plot to ensure homogeneity of the primary sample.

Sugar cane analysis

The sugar cane samples were milled to obtain a pulp, rich in fiber and juice, for the saccharimetric assays. In practice, stems are introduced into the upper orifice of a Jeffco grinder, while the pulp is collected in a metal tank disposed in the lower part of the machine. The cane juice was extracted using a hydraulic press on 500 g of mass of pulp. The determination of the technological parameters of sugarcane was carried out according to the methods described by HOARAU and al. Cf. table 2.

Table 2: Technological characteristics of sugar cane varieties

Ranks	Variables	Abreviation (units)	Méthods of measurement
1	Brix degré	brix	Determined by using a refractometer, and corrected by using a temperature table. Determined using a polarimeter according to the method of Hoarau.
2	Polarity of the juice	Pol	**Pol jus = Pol Factor x read Pol**
3	Purety of juice	Juice purety (%)	Indicating the sucrose content in cane juice, it is determined by the formula: **Purety = (Juice Pol / Brix) x 100**

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

4	Saccharine richness	Pol cane (%)	Corresponds to the sucrose rate in sugarcane, it is determined by the formula : **Pol % cane = Factor n x Juice pol**
5	Fiber content	Fiber (%)	It is determined by using a table from the mass of the "cake" obtained after pressing 500 g of pulp resulting from the grinding of the cane sample.
6	Extractible sugar	TSE (TSE / ha)	It is determined by the saccharine content, the fiber content in the cane and the purity of the cane juice (Fauconnier, 1991): **SE % C = [(0.84 x Pol %C) (1,6 - 60 / Purety)- (0,05 x Fiber % C)]**.

Agro-morphological characters of varieties

Seven agro-morphological characters were measured to monitor the performance of the varieties tested (table 3).

Table 3: Agro-morphological characters and methods of measurement

Ranks	Caractères	Abrevitions (units)	Methods of measurement
1	Flowering	Flo (%)	Calculated by multiplying by 100 the quotient of the number of stems in flowering inflorescence by the total number of stems of the variety.
2	Whips	Whips (Whips / ha)	Counted by counting stalks carrying a whip. A linear extrapolation of this number is made per hectare.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

3	Stems per hectare	Stems (Stems / ha)	Number of rods machinable over the length of the micro-plot x 1.5 and reported per hectare.
4	Lenght of stems	Lenght (cm)	Determined by using a tape measure at harvest. The measurements are made on the sweet portion of a sample of ten canes. The average of the measurements is retained.
5	Masse de tige	M tige (g)	Evaluated by using a scale on a sample of 10 machinable rods. The average of the measurements is retained.
6	Diameter of stems	D stem (mm)	Measured by using a caliper on a sample of 10 machinable rods. The average of the measurements is retained.
7	Attacked internod	ENA (%)	Corresponds to the ratio of the number of attacked internodes to the total number of internodes.

Statistical analysis

The results obtained were analyzed by using of the Statistica 7.0 software. When a significant difference existed between averages, a DUNCAN post ANOVA test was performed to rank them.

RESULTS

Tests under irrigation at the beginning of harvesting season

Technological qualities and yields at harvest

Concerning technological qualities (purity and fiber) of sugar cane, statistical analysis showed a highly significant difference between varieties (table 4). For purity, the averages have been classified into three homogeneous groups. The highest average group contain only Co449 (89.3), followed by TUC7215 (87.1) which has an intermediate purity between the group of low purities and the highest. Lowest averages group include TUC7216 (84.1), R83176 (84.5), NCo376 (84.6) and R579 (84.8).

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

Table 4: Comparison of technological qualities and yields at harvest

	Tested varieties	Technological quality (% Cane)			Yield	
		Purety	Pol	Fiber	Cane (tc/ha)	Sucrose (tse/ha)
	R83176	84.5 c	14.3 a	13.7 a	84.0 c	7.8 b
	TUC7216	84.1 c	12.0 b	15.1 a	82.5 d	6.8 c
	TUC7215	87.1 b	14.4 a	14.1 a	80.3 d	7.7 b
	R579	84.8 c	13.7 a	12.4 b	115.2 a	10.5 a
	Co449	89.3 a	14.2 a	14.5 a	86.3 c	8.3 b
	NCo376	84.6 c	12.8 b	14.2 a	91.6 b	8.0 b
	Mean	86.0	14.0	14.0	90.0	8.2
	CV (%)	2.4	7.0	6.5	14.4	14.6
	ETmoy.	2.0	0.9	0.9	12.9	1.2
P value	Bloc effect	0.12	0.08	0.07	0.09	0.08
	Year effect		0.01	0.002	0.01	0.6
	Variety effect	0.01	0.01	0.001	0.004	0.003
	Inter. yera-trait.	0.001	0.00	0.04	0.01	0.01

Significant: P value < 5 p.c.
Highly significant: P value < 1 p.c.
a, b, c, d: in the same column, the averages followed by the same letters are not significantly different at the 5 p.c. threshold according to the Duncan test

Regarding fiber, two homogeneous groups have been identified. The one with the highest amount of fiber consists R83176 (13.7 p.c.), TUC7215 (14.1 p.c.), NCo376 (14.2 p.c.), Co449 (14.5 p.c.), and TUC 7216 (15.1 p.c.).

In terms of yield (cane and extractible sugar), a very significant difference was also observed between varieties. In the case of cane yield, varieties were classified into four homogeneous groups. Highest cane yield group includes only of R579 (115.2 tc/ha). The one with the lowest cane yields has TUC7215 and TUC 7216 with respectively (80.3 and 82.5 tc/ha). The controls,

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

NCo376 (86.3 tc/ha) and Co449 (91.6 tc/ha) form a group located between the two previous ones.

For extractible sugar content, three homogeneous groups were formed. The group with the highest extractible sugar content includes only R579 (10.5 tse/ha) is. The lowest value was observed in TUC7216 (6.8 tse/ha), which consists the group with the lowest average. The third group contains varieties whose extractible sugar content are between those of the two previous ones. It consists of TUC7216 (7.7 tse/ha), R83176 (7.8 tse/ha), NCo376 (8.0 tse/ha) and Co449 (8.3 tse/ha).

For these determinant criteria in the selection of sugar cane, the variety R579 outperformed the controls NCo 376 and Co449. With the exception of fiber, the year-treatment interaction was highly significant for all the technologicals and yield criteria of sugar cane.

Agro-morphological characters and tolerance to biotic factors

Regarding flowering, all varieties had rates above 30 p.c. (table 5). Thus, R579 with the lowest flowering rate was distinguished with 31 p.c., unlike TUC7215 which had the highest rate (60 p.c. of flower). Flowering rates of Co449, NCo376, TUC7216 and R83176 was situated between 54 and 58 p.c.. For this agro-morphological character, R579 was better than the two controls.

Table 5: Morphological characteristics and tolerance to biotic factors at the beginning of the season

Tested varieties	Floring (p.c.)	Whips/ha (-)	Stems / ha (x 10^3)	L stem (cm)	M stem (g)	D stem (mm)	ENA (p.c.)
R83176	55	5767	113	187.1	525	18.1	2.3
TUC7216	55	2367	125	239.3	583	17.0	1.6
TUC7215	60	633	94	217.8	788	20.6	5.5
R579	31	50	109	206.0	729	19.5	3
Co449	58	733	128	203.5	592	18.3	3.2
NCo376	54	16683	130	225.3	617	18.9	7.9

The number of stems per hectare reveals that NCo376 and Co449 are the varieties with the best tillings ; respectively 130 000 and 128 000 stems / ha. Only TUC 7215 tillings (94 000 stems / ha) was less than 100 000 stems / ha.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

The length of stems showed that TUC7216 has the longest stems (239.3 cm). For this character, only R83176 could not reach 200 cm.

The diameter of the stems indicates TUC7215 has the largest stems (20.6 mm) unlike TUC7216 whose stems are the thinnest (17.0 mm). The diameter of R579 stems (19.5 mm) is superior to those of the controls, respectively at 18.3 and 18.9 mm.

In terms of number of black whip-like, R579 (50 whips/ha) was the most tolerant variety. NCo376 is the most susceptible variety with 16683 whips/ha. It is followed by R83176 which have 5767 whips/ha. For this character, R579 was better than both controls.

In addition, TUC7216 with 1.6 p.c. of ENA was the most tolerant to Eldana sp., Followed by R83176. R579 with 3 p.c. of ENA was as tolerant as Co449 (3.2 p.c.) to Eldana sp .. Contrariwise, it had a higher tolerance level than the NCo376 control (7.9 p.c.).

Tests under irrigation at the end of haversting season

Technological qualities and yields at harvesting

For all technologicals criteria, statistical analysis revealed a highly significant difference between varieties (table 6). Purity, allows to classify varieties in three groups. Thus, PS59 (90.4 p.c.) was the only variety in the group having highest purity. The group with the lowest purity values include FR90831 (85.9); R579 (85.9) and TUC7216 (86.2). Between these two groups exist FR90925 (88.5), Co449 (89.6) and Co957 (88.3).

Regarding the fiber content, two homogeneous groups have been formed. The first consists of varieties TUC 7216 (15.5); FR90831 (15.5); Co449 (14.7) and Co957 (15.1) which have the highest fiber contents. The lowest averages are recorded by FR90925 (12.7 p.c.), PS59 (13.9 p.c.) and R579 (12.8 p.c.) which constitute the second group.

Significant differences were also highlighted in the yield criteria (table 6). R579 has the best cane tonnage / ha (111.7 tc / ha). The smallest cane tonnages are produced by TUC7216 and FR90931 which both have 81.5 tc / ha. The two controls Co449 and Co957 have respectively 85.1 tc/ha and 95.6 tc/ha.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

Table 6: Comparison of technological qualities and yields at harvest

	Tested varieties	Technological quality (% Canne)			Yield	
		Purety	Pol	Fiber	Cane (tc/ha)	Sucrose (tse/ha)
	TUC7216	86.2 c	12.8 d	15,5 a	81.5 d	6.8 e
	FR90831	85.9 c	13.3 d	15.5 a	81.5 d	7.3 d
	FR90925	88.5 b	15.0 b	12.7 b	83.3 cd	9.0 b
	PS59	90.4	15.5 a	13.9 b	87.0 c	9.2 b
	R579	85.9 c	13.7 c	12.8 b	111.7 a	10.7 a
	Co449	89.6 b	14.4 c	14.7 a	85.1 c	8.2 c
	Co957	88.3 b	13.8 c	15.1 a	95.6 b	8.8 b
	Mean	87.8	14.1	14.3	89.4	8.6
	CV (%)	2.1	6.9	8.4	12.2	15.1
	ETmoy.	1.8	1.0	1.2	11.0	1.3
P value	**Bloc effect**	0.06	0.09	0.08	0.07	0.08
	Year ffet	0.001	0.002	0.004	0.004	0.07
	Traitement effect	0.01	0.03	0.01	0.001	0.0002
	Inter. Year-trait.	0.003	0.01	0.03	0.001	0.003

R579 with 10.7 tse/ha has the highest extractible sugar content. This variety is followed by FR90925, PS59 and Co957 which have respectively 9.0; 9.2 and 8.8 tse / ha. TUC7216 (6.8 tse/ha) has the lowest value. By comparing values of extractible sugar of R579 at the end of haversting season to whose of beginning haversting season, we realize that they are similar (figure 1).

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

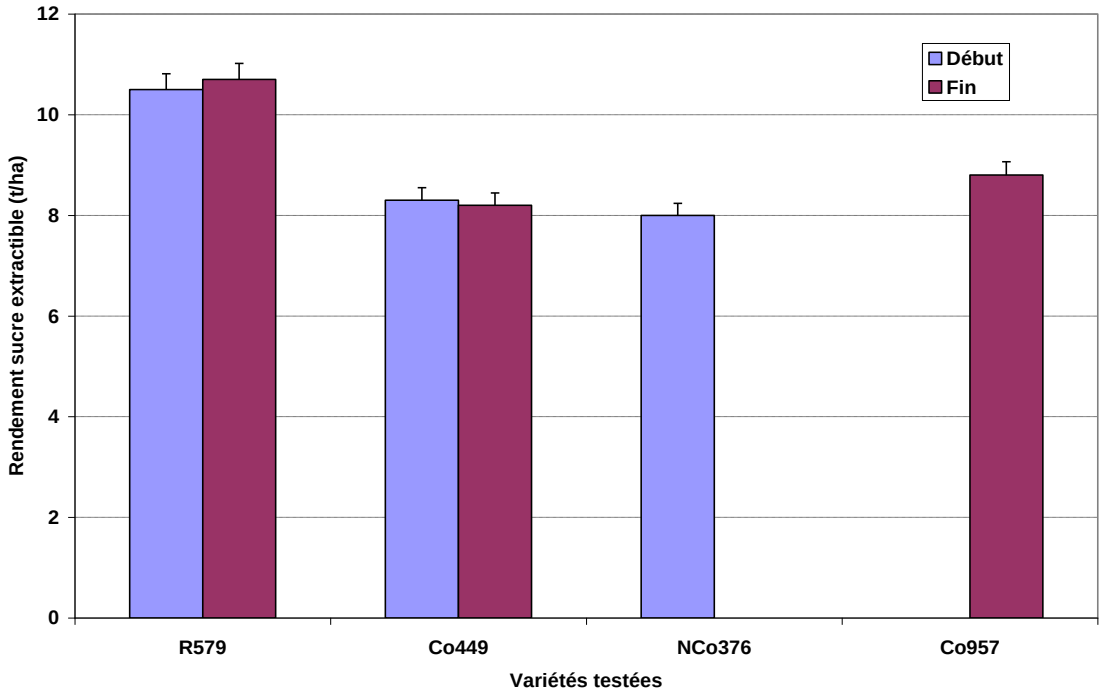

Figure 1: Extractable sugar yields under irrigation at the beginning and end of the R579 season and controls Co449, NCo376 and Co957

Apart from the fiber, a highly significant year-treatment interaction was observed for all the technological and yield criteria. The fiber content does not depend to variability of seasons. It is a genetic factor.

Agro-morphological characters and tolerance to biotic factors

The flowering of the Co957 variety is the latest (table 7). No flower was observed on this variety during the study. The varieties FR90925 and FR90831 are the most flourishing, they have respectively 60 and 55 p.c. of flowers. The flowering rate of R579 is 14 p.c.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

Table 7: Morphological characters and tolerance to biotic factors at the end of the season

Tested varieties	Floring (p.c.)	Whips/ha (-)	Stems / ha (x 1000)	L stem (cm)	M stem (g)	D stem (mm)	ENA (p.c.)
TUC7216	45	1867	112	239.3	629	18.3	2.2
FR90831	55	83	102	200.1	688	20.2	4.0
FR90925	60	367	93	109.0	825	20.8	3.0
PS59	47	167	105	185.6	604	20.1	7.7
R579	14	130	106	216.8	888	21.8	1.8
Co449	58	100	122	174.3	479	18.4	3.8
Co957	0	8800	96	164.2	746	22.6	3.2

L stem: length of a stem **D stem: diameter of a stem**

M stem: mass of a stem **ENA stem: rate of internodes attacked by *Eldana* sp.**

Whips / ha: whips per hectare **Stems / ha: number of stems per hectare**

Regarding the number of stems per hectare, Co449 is the most performing with 122 000 stems/ha. The variety FR90925 has the lowest tillering (93 000 stems/ha).

The longest stems were observed in TUC7216 (239.3 cm). The controls Co449 and Co957 have respectively 174.3 and 164.2 cm of stem length. FR90925 with 109.0 cm produces the shortest stems.

The largest cane stems are those of Co957 (diameter = 22.6 mm). The finest stems are those of TUC7216 which are 18.3 mm of diameter.

The variety FR90831 is the most tolerant to smut. It has 83 black whip-like per hectare while Co957 and TUC7216 have respectively 8,800 and 1,867 black whip-like per hectare. These last two varieties are the most susceptible to this disease. In R579, 130 black whip-like were observed.

During this test, R579 was the most tolerant to attacks by *Eldana* sp .. Only 1.8 p.c. of internodes of this variety were attacked by this pest. The most sensitive variety to this borer is PS59, in which 7.7 p.c. of internodes were attacked.

Rainfall adaptation tests

Technological qualities and yields at harvest

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

Apart from purity, the statistical analysis revealed significant differences between the varieties for the fiber content, cane tonnage per hectare and extractible sugar yield (P = 0.005, P = 0.003, P = 0.003 and P = 0.002) (table 8). Thus, R579 has 90.4 p.c. purity; NCo376 and Co957 having respectively 89.2 and 90.7 p.c. of purity. Varieties from Brazil SP791230; SP75184 and SP71821 have 89.7 respectively; 90.2 and 91.1 p.c. of purity. The percentage of fiber structures varieties in four homogeneous groups. Thus, the group with the highest averages contains SP75184 (15.0) and Co957 (15.1 p.c.). The class with the lowest percentage of fiber consists exclusively of R579 which obtained 12.9 p.c.

Table 8: Comparison of technological qualities and yields at harvest

	Testes varieties	**Technological quality (% Canne)**			**Yield**	
		Purety	**Pol**	**Fiber**	**Cane (tc/ha)**	**Sucrose (tse/ha)**
	R579	90.4a	16.4 b	12.9 d	79.6 a	95 a
	SP791230	89.7	15.9 b	13.8 c	43.7 c	5.1 c
	SP75184	90.2a	16.2 b	15.0 a	42.9 c	5.1 c
	SP718210	91.1a	17.1 a	13.9 c	71.3 b	9.1 a
	NCo376	89.2a	15.3 c	14.3 bc	72.3 b	8.0 b
	Co957	90.7a	15.9 b	15.1 a	70.6 b	8.3 b
	Mean	90.2	16.1	14.2	63.2	7.5
	CV (%)	2.7	5.0	11.0	9.0	9.8
	ETmoy.	2.4	0.8	1.5	5.7	0.7
P value	Bloc effect	0.07	0.06	0.07	0.08	0.08
	Year effect	0.08	0.002	0.001	0.003	0.06
	Trait effect	0.07	0.005	0.003	0.003	0.002
	Inter. year-trait.	0.09	0.006	0.08	0.002	0.004

Significant: P value <5 p.c.

Highly significant: P value <1 p.c.

a, b, c, d: the averages followed by the same letters in the same column are not significantly different at the 5 p.c. threshold according to Duncan's test

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

Within the yield parameters significant differences were highlighted between the varieties. Thus, among the three groups formed, the one with the highest averages contains only R579 which obtained 79.6 tc/ha. The class with the lowest values consists of SP71184 (42.9 tc/ha) and SP791230 (43.7 tc/ha). SP718210, NCo376 and Co957 constitute an intermediate group between the two previous ones. These varieties produce respectively 71.3; 72.3 and 70.6 tc/ha.

For the extractible sugar tonnage per hectare, three homogeneous groups have been established. R579 (9.5 tse/ha) constitutes with SP718210 (9.1 tse/ha) the group with the highest values (figure 2). The two controls NCo376 and Co957 which generate respectively 8.0 and 8.3 tse/ha constitute a group less performing than that formed by R579 and SP718210. In this test too, the year-treatment interaction was highly significant for Pol, tc/ha and tse/ha.

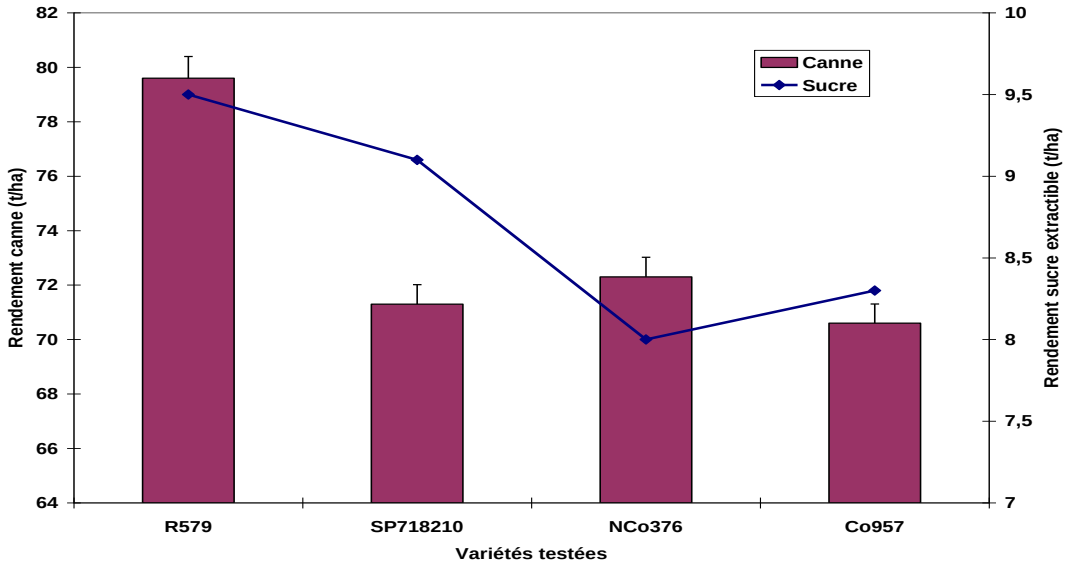

Figure 2: Rainfall yields of varieties R579, SP718210, NCo376 and Co957

Agro-morphological characters of varieties

The results show that flowering is greater in SP718210 with 80 p.c. of the canes carrying inflorescences (table 9). In contrast, Co957 (0 p.c.) and SP791230 (6 p.c.) have the lowest flowering rates.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

Table 9: Morphological characteristics and tolerance to biotic factors in rain conditions

Tested varieties	Floring (p.c.)	Whips/ha	Stem/ha (x 10^3)	L stem (cm)	M stem (g)	D stem (mm)	ENA (%)
R579	11	56	98	201.3	1028	22.1	1.7
SP791230	6	486	52	196.8	967	21.8	5.5
SP75184	26	10640	38	216.5	1013	22.4	5.5
SP718210	80	14	62	214.5	1117	24.4	4.7
NCo376	37	16014	109	197.7	690	19.3	5.5
Co957	0	17431	79	190.5	853	21.7	2.1

These results also show that R579 is the most tolerant variety to smut (56 whips/ha) when SP75184; NCo376 and Co957 show a high sensitivity to the disease, respectively with 10 640; 16,014 and 17,431 whips / ha. NCo376 and R579 produce the largest number of stems, respectively 109,000 and 88,000 stems / ha. All varieties were tolerant to *Eldana saccharina*. There are attack rates between 1.7 and 5.5 p.c. In particular, R579 had only 1.7 p.c. of its internodes attacked by the pest.

DISCUSSION

Tests under irrigation

At the beginning and at the end of the harvesting, R579 produced extractible sugar yields (10.5 tse/h and 10.7 tse/ha) higher than those of the controls Co449, Co957 and NCo376 whose values ranged between 8 and 8.8 tse/ha. In R579, these results could be explained by a biosynthesis of sucrose at the expense of the fibers. Our results confirm those of [12] which showed a negative correlation (between -0.65 and -0.76) between the sucrose content and the fiber content. In fact, the biomass produced by sugar cane is shared mainly between sugar and lignocellulose. In addition, according to these authors, a satisfactory water supply directs the metabolism of sugar cane towards an abundant production of fiber while a lack of water promotes the concentration of sucrose. Our results invalidate this last statement but confirm those of [13,14]which stipulate that irrigation under Ferkéssédougou conditions is a determining factor for obtaining satisfactory sugar yields. Our observations also corroborate those of [15] who found yield gains in a wheat variety following sufficient irrigation at different phenological stages.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

The results of this study also showed that the flowering rate of R579 is low at the end of the harvesting season (14 p.c.) and medium (31 p.c.) at the beginning of the harvesting season. This would partly justify his good performance at these two periods in Ferkéssédougou. Indeed, a strong flowering inhibits, on the one hand, the growth of the stem of sugar cane and on the other hand gradually decreases the saccharine wealth by transforming the sucrose into Adenosine Triphosphate (ATP) in the cycle of KREBBS [16]. This weak flowering of the R579 variety is an advantage because most of the varieties tested up to now Ferkéssédougou produce moderately or weakly at the end of the harvesting season.

Concerning the susceptibility to stem borers (*Eldana saccharina*), the results showed that the highest infestation rate in both trials was 3 p.c. in R579 against 8 p.c. for NCo376 which is the most sensitive variety in the perimeters in Ferkéssédougou sugar industry.

The tolerance of R579 to *Eldana saccharina* is in agreement with the results of [17]. It's likely in relation to the action of soluble phenolic compounds [18]. Phenolic compounds play a notorious role in the defense mechanisms of plants to parasitic infections [19,20] and have an important effect in the repulsion of plants against many phytophages [21]. Moreover, it's knowned that phenolic compounds enter into the constitution of lignins and suberin, thus ensuring the rigidity of the wall of plant cells,those the strengthening of which constitutes a protective barrier against drying, penetration of micro-organisms or else the attacks of phytophageous insects [22]. Few data currently exist regarding the biochemical mechanisms involved in the interaction of the sugar cane-*Eldana saccharina*, including phenolic compounds in repulsion processes [23]. In olive trees, the determination of soluble phenol levels of youngs plants of different cultivars has allowed to distinguish cultivars rich in phenolic compounds, which are moderately rich in phenols, and cultivars with low levels of soluble phenols. The comparison of the results obtained in the field to those obtained in the laboratory shows that the most attacked cultivars have the lowest levels of soluble phenols compared to the most tolerant cultivars. We might think that the tolerance of R579 is due to a high concentration of phenolic compounds soluble in its cells unlike those of the other varieties studied. In addition, there is a reported decrease in borers attacks by sprinkler irrigation [24]. Thus, we might think that the irrigation performed during this test contributed to reduction of borers attacks on R579. These results confirm those of [25]. In fact, these authors observed a variability in the sensitivity of R579 to *Eldana saccharina* in irrigated or rainy conditions in Reunion Island.

This pest is perceived as a major biotic constraint. When he eats in sugar cane stems, *Eldana saccharina* takes a certain amount of marrow. This loss is minimal, compared to that resulting from the arrest of the development of the stems by destruction of the apical meristem or the loss of sugar by chemical transformations due to the salivary enzymes of borer and its droppings [16].

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

In the world, studies by [26] have estimated losses due to borer to 10% of the crop. The losses of sugar caused by this pest are estimated between 40 and 70 p.c. of the rate of internodes attacked by this one [27]. In South Africa, [28,29] estimated the damage caused by borers between 6 and 10 million Euros. This is why, given the flexibility of the R579 tissues, it would be advisable to cultivate it under irrigated conditions.

Test in rainfall conditions

The R579 variety has a technological performance (9.5 tse/ha) that is significantly better than that of the control NCo376. Thus, R579 would tolerate drought better than NCo376 known for this character. Several authors explain the tolerance of plants to water stress. According to [30], the tolerance of a plant to drought can be explained on the one hand by its ability to maintain high levels of stomacal conductance and leaf water potential in times of water stress and other hand by a low speed of senescence of the leaves and tillers. [31] found increased expression of a gene encoding an existing peroxidase only in a drought tolerant sugar cane cultivar. We might think that varieties NCo376 and R579 use these drought tolerance mechanisms. However, R579 would better exploit these pathways of adaptation. This hypothesis is reinforced by the idea that the number of harvestable stems decreased by 10 p.c. for R579 (109,000 to 98,000 stems/ha) and 16 p.c. for NCO376 (130,000 to 109,000 stems/ha) from irrigated to rainfall conditions. Our results confirm the observations of [32], which states that the number of stems / hectare is one of the three components of yield, those the significant decrease during periods of water stress attesting to the tolerance or otherwise of sugarcane cultivars to drought. They also corroborate those of [33] who highlighted in Mauritius, a decrease in the number stems/ha, the number of internodes/stems and the length of stems in varieties susceptible to water stress.

The low flowering rate of R579 (<15 p.c.) noted in this study would also contribute to better growth potential and therefore yield compared to NCo376 cultivars. According to [34] late intervention of sugar cane flowering prevent the loss of a number of months of growth and sugar.

The results also showed that R579 (56 whips/ha) is more tolerant to smut than controls NCo376 (16,014 whips/ha) and Co 957 (17,431 whips/ha). This would be due to R579 cells whose arrangement does not allow easy penetration of smut hyphae.

In view of these results, the prospect of developing R579 in rainfall conditions to the detriment of the susceptible cultivars NCo376 and Co957 would be an opportunity to reduce the pressure of the smut whose propagation is favored in rainfall conditions [35,36].

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

CONCLUSION

According to the Ferkéssédougou study, the R579 cultivar performs well as well as under irrigation, at the beginning and end of the haversting season, but also in rainfall conditions. In fact, it outperforms the best control of about 25 p.c. under irrigation at the beginning and end of the harvesting season and 18 p.c. in rainfall conditions, with in addition a good tolerance to smut and drought. It reachs 10.5 and 10.7 tse/ha or 115.2 and 111.7 tc/ha under irrigation at the beginning and end of the harvesting season, respectively. In rainfall conditions, its average performance amounts to 9.5 tse/ha (or 78.6 tc/ha) compared to 8.3 tse/ha (or 70.1 tc/ha) for the best control Co957. These results lead to the development of the R579 variety in both village plantations (to the detriment of the susceptible cultivars NCo376 and Co957) and in irrigated conditions at the beginning or end of the haversting season.

REFERENCES

[1] LAKSHMANAN P., GEIJSKES R. J., AITKEN K.S., GROF C.L.P., BONNETT G.D., SMITH G.R., 2005. Sugarcane biotechnology: the challenges and opportunities. In Vitro Cell Dev Biol Plant 41: 345-363

[2] MATSUOKA S., FERRO J., ARRUDA P., 2009. The Brazilian experience of sugarcane ethanol industry. In vitro Cell Dev-Pl 45: 372-381 pp.

[3] GRIVET L. and ARRUDA P, 2001. Sugarcane genomics: depicting the complex genome of an important tropical crop. Current Opinion in Plant Biology 5: 122-127 pp.

[4] GRIVET L., D'HONT A., ROQUES D., FELDMANN P., LANAUD C., GLASZMANN J.C., 1996. RFLP mapping in cultivated Ssugarcane (Saccharum spp.): Genome organization in a highly polyploid and aneuploid interspecific hybrid. Genetics 142: 987-1000

[5] ORIOL P. and DOMAINGUE R., 2008. Varietal selection of sugar cane: a lever to support the competitiveness of farms in the South. In: Sugar cane. CIRAD, Montpellier. Pp 1-2. http://www.cirad.fr 22/05/2008.

[6] BOUHARMONT J., 1992. Studies of constraints related to high altitude rice growing and development of varieties adapted to these conditions. Final report of the CEE / STD2 project, 22 pages.

[7] JANET C., GORSE P., NICOLAS F., 1981. The development of biotechnologies in agricultural and food systems Journal of Industrial Economics Year 1981 18 pp. 180-191.

[8] KOUAME K. D., PENE C.B., ZOUZOU M., BOMO M.B., OUATTARA Y., 2012. Varietal Selection of Sugar Cane in Ivory Coast: summary of results and proposal of a new selection scheme. European Journal of Scientific Research ISSN 1450-216X Vol.84 No.2 (2012), 194 - 209 pp.

[9] MORDOCCO A., J. J. STRINGER and M. C. COX, 2007. District adoption patterns of commercial sugarcane varieties to increase economic returns to the Australian sugar industry. Sugar Cane International 25: 3-6.

[10] GILBERT R. A., SHINE J.M., MILLER J.D., RICE R. W. and RAINBOLT C.R., 2006. The effect of genotype, environment and time of harvest on sugar cane yields in Florida, USA. Field Crops Research 95: 156-170 p.

[11] MA'ALI, S.H., 2008. Additive mean effects and multiplicative interaction analysis of maize yield trials in South Africa. South African Journal of Plant and Soil 25: 185-193.

[12] JACKSON P., 1994. Genetic relationships between attributes in sugarcane clones closely related to *Saccharum spontaneum*. Euphytica 79 : 101-108 pp..

[13] PENE C. B., and DEA G. B., 2000. Varietal improvement of sugar cane in Côte d'Ivoire. In: 1st regional workshop on varietal improvement of sugar cane in West and Central Africa, Yamoussoukro: 98-102 pp.

[14] PENE C.B., ASSA D.A. and DEA B.G., 2001. Irrigation water-sugarcane varieties under water rationing conditions. Cahiers Agricultures 10 (4): 243-253.

[15] DAROUI E. A., BOUKROUTE A., KAJEIOU M., KOUDDANE N-E. and BERRICHI A., 2011. Effect of supplemental irrigation on the yield ofa wheat crop tender (Triticum aestivum L.) (Rajae variety) in Eastern Morocco

[16] COCHEREAU P. and JEAN-BART A., 1990. The tonnage losses on sugar cane in Guadeloupe (Grande-Terre): evaluation and probable causes. Tropical agronomy, 45-3, 179 - 196 pp.

[17] KOUAME D. K., PENE C. B., ZOUZOU M., KOULIBALY S. G., TUO K., AKPA A., 2009. Evaluation agronomique de variétés de canne à sucre en début de campagne de récoltes à Ferké au Nord de la Côte d'Ivoire : vers un allègement du schéma de sélection. *Agronomie Africaine* 21 (3): 215-330.

[18] HARBORNE J. B. and DEY P. M., 1993. Methods in plant biochemistry, academic press, Volume 4, 293 p. [19] METRAUX J. P. MEUWLY P., 1993. *Ortho*-Anisic Acid as Internal

Standard for the Simultaneous Quantitation of Salicylic Acid and Its Putative Biosynthetic Precursors in Cucumber Leaves. Volume 214, Issue 2, 1 November, Pages 500-505 pp..

[20] MICHALEK S., MAYR U., TREUTTER D., LUX-ENDRICH A., GUTMANN M., FEUCHt W. and GEIBEL M., 1996. role of flavan-3-ols in resistance of apple trees to *venturia inaequalis* acta hortic. 484, 535-540 pp..

[21] DAUGROIS J., MICHEL H. and MIKE P., 2005. Epiphytic colonisation and infection by *xanthomonas albilineans* of two sugarcane cultivars differing in resistance to leaf scald disease. in: guatemala: international society of sugarcane technologists : 678-684 pp..

[22] CHAMPOISEAU P., CHANG F., PETER R. et CHAGMAN T., 2009. Epiphytic populations of *xanthomonas albilineans* and subsequent sugarcane stalk infection are linked to rainfall in guadeloupe. *plant disease*. 93(4) : 339-346 pp..

[23] ZHANG L., 1999. Factors affecting biosynthesis by *xanthomonas albilineans* of albicidin antibiotics and phytotoxins, *journal of applied microbiology*. 85(6) : 1023-1028 pp..

[24] TIBERE R, GAUVIN JC, ROCHAT J, GOEBEL R. 2001. Incidence of the punctual driller in Réunion. In: Integrated fight against the punctured driller. Protection of the plant. CIRAD, Sugarcane Program: 22-23.

[25] ROTT P. et DAVIS M., 2000. Leaf scald. in: *a guide to sugarcane diseases*, ed. rott p, bailey r, comstock j, croft b, saumtally a, montpellier: cirad-issct : 339 p.

[26] Tran M., 1981. Reconnaissance des principaux foreurs de tiges du riz, du maïs et de la canne à sucre en côte d'ivoire. initiations-documentations techniques, (48). orstom-paris : 23 p..

[27] IRAT-CIRAD, 1985. *Eldana saccharina* Walker: corn borer and cereals.Ed. IRATCIRAD: 1-2 pp.

[28] KEEPING M. G., 1995. Coping with pest in the South Africa Sugar Industry. Proceeding of the South African Sugarcane Technologists Association 69: 217-218 pp.

[29] GOEBEL F.R. and WAY M.J., 2003. Investigation of the impact of *Eldana saccharina* (Lepidoptera : Pyralidea) on sugarcane yield in field trials in Zululand. Proceeding of the South African Sugarcane Technologists Association 77: 256-265 pp.

[30] SMIT M. A and SINGELS A., 2006. The response of sugarcane canopy development to water stress. Field Crops Res. 98 (2006): 91-97.

ISSN: 2455-6939

Volume:04, Issue:04 "July-August 2018"

[31] RODRIGUES F. A., LAIA M.L., ZINGARETTI S.M., 2009. Analysis of gene expression profiles under water stress in tolerant and sensitive sugarcane plants. Plant Sci 176: 286-302 Rozeff N (1995) Sugarcane and salinity-a review paper. Sugarcane 5: 8-19 pp.

[32] DE ALMEIDA SILVA M, SOARES RAB, ANDREADE LANDELL, MG, CAMPANA MP, 2008. Agronomic performance of sugarcane families in response to water stress. Bragantia Campinas 67 (3): 655-661 pp.

[33] DOMAINGUE R., 1996. Family and Varietal Adaptation of Sugarcane to Dry Conditions and Relevance to Selection Procedures. In: Proceedings of the 21st ISSCT

[34] D'HONT A., ISON D., ALIX K., ROUX C., GLASZMANN J.C., 1998. Determination of basic chromosome numbers in the genus *Saccharum* by physical mapping of ribosomal RNA genes. Genome 41: 221-225 pp.

[35] FONTANIELLA B., MARQUEZ A., RODIGUEZ C.W., PINON D., SOLAS M.T., VICENTE C., LEGAZ M.E. 2002. A role of sugar cane glycoproteins in the resistance of sugar cane to Ustilago scitaminea. Plant Physiol. Biochem. 40 (10): 881-889 p.

[36] WADA A. C., 2003. Control of sugarcane smut disease in Nigeria with fungicides. Crop Protect. 22 (1): 45-49.

