UDC 633

THE RESULT OF A TWO-STAGES CROSS INTRA AND INTERSPECIFIC SELECTION OF SUGAR CANE CROP POTENTIAL CLONES

Herwati Anik*, **Supriyono**
Balai Penelitian Tanaman Pemanis and Serat, Indonesia
*E-mail: anikherwati@gmail.com

ABSTRACT

Sugarcane is one of strategic and important food commodities in Indonesia because it is the main source of sugar producers. Domestic sugar production in 2015 only reached 2.5 million tons, while its needs are 5.6 million tons which resulting in a shortage of 3.1 million tons to be met from import. The production in 2016 just reached 2.5 million tons causing the shortages that must be filled by import as much as 3.1 million tons. The Ministry of Agriculture has a program for sugar self-sufficiency that is expected to be achieved by 2014 with production is expected to reach 5.7 million tons. The discrepancy between production levels at this time with the target in 2014 still quite wide. The target accession can be reached by intensification and land extension or expansion. The availability of land development with the availability of adequate water has to face obstacles competing with rice plant as the main staple food. In 2007 more than 60% sugar cane crop was in dry land (Hadisaputro, et al., 2008). The expansion of dry land still has an opportunity to be developed in various ways such as the availability of sugar cane varieties with drought resistant. The research objectives are to accomplish the drought resistant selection in the field to the result of crossbreeding clones in 2014 (MLG-14). The activities implemented in KP. Karangploso, Malang, started on January until December 2016. The research materials are 51 crop clones of two stage selection which 7 varieties are PSDK, PSJT 941, PS 881, PSJK, VMC 76-16, GLAGAH, ERIANTHUS, CENING, BL, and PS 881 as a control. Using a randomized block design with three replication were planted in plots consisting of three arc along the 5 m. The PKP range (from center to center of arc) are 100 cm length. The range between replications is 2.5 – 3 cm length. The seeds form is a one eye mule (bud set). Furthermore, after 1.5 month old, the seeds were selected based on its uniformly conditions and then planted in the segment with the range of 50 cm length between plants, so the plants amount per plot as many as 30 plants. Fertilizer dose of 160 kg N + 70 kg P_2O_5+ 60 kg K_2O per hectare or equivalent to 800 kg ZA + 200 kg SP36 + 100 kg KCl per hectare. Observation were did at the age of 11 months. The parameter that being observed were plant height, stem lenght, number of stems/ clump, steam diameter, number of segments, heavy stems intact, heavy stem/ m, the brix average, and voos of stem. The result showed the highest parameters in comparison with the parent for plant height (347 cm) and the stem lenght (301 cm) is MLG 02/14/86, the number of stem, not voos of stem productive MLG 14/2/42 (45 stems), stem's diameter and not voos of stem,VMC 76-16 (39.8 cm), not voos of stem, the amount of segments MLG 14/5/15 (27 segments), not voos of stem and ERIANTHUS (27.6), stem's weight, MLG 14/2/44 (2.12 kg), and the brix average value not voos of stem and BL (24.7%) not voos of stem.

KEY WORDS

Selection, sugar cane crop, crossing result, interspecific.

Sugar cane is one of the strategic and important food commodities in Indonesia because it is the main source of sugar producers. Domestic sugar production in 2010 only reached 2.4 million tons resulting in shortages to be met from imports. Ministry of Agriculture has a program for sugar self-sufficiency which is expected to be achieved in 2014 while the production is expected to have reached 5.7 million tons (Ditjenbun, 2016).

The sugar cane cultivated at this time is not only the result of the selection of a single species but is actually the result of evolution and hybridization as well as a selection of the

Saccharum complex. This hybridization occurs both naturally and with human intervention. The saccharum complex consists of Saccharum, Erianthus, Miscanthus, Sclerostachya, and Narenga. The number of chromosomes in sugar cane and some of its families are S. officinarum 80 pairs, S. spontaneum 36-128 pairs, Erianthus 20-100 pairs (Besse, et al., 1997; Daniels & Roach, 1987; OGTR, 2008; Henry, 2010; Zang, 2012). Currently modern sugar cane varieties are the hybridization of S. officinarum with S. spontaneum and backcross with 100-130 chromosomes with 80-90% composition of S. officinarum and 10-20% of S. spontaneum (Souza, et al., 2011).

The achievement of sugar cane production target can be reached by intensification and extensification or land expansion. The availability of land development with sufficient water availability is constrained because it has to compete with food crop commodities that become staple food. In 2007 more than 60% of sugar cane plantation was on dry land (Hadisaputro, et al., 2008). The expansion to dry land is still has chance to be developed in various ways including the availability of drought-resistant sugar cane varieties.

One of the problems faced in developing dry areas is the availability of improved varieties that are tolerant or resistant to these conditions. This problem can be solved by assembling the suitable sugar cane varieties for dry land. This dry-resistant varieties assembly can be carried out by incorporating the dry-resistance carrier genes owned by close relatives of sugar cane such as Saccharu spontaneum and Erianthus spp. Erianthus has drought-tolerant and puddle-tolerant properties, but it also has advantages in ratoon ability, vigor, and resistance to pests and diseases (Berding & Roach, 1987; Beese & McIntyre, 2000; Harvey, et al., 1998).

The problem faced in the hybridization of sugar cane with its close relatives is the flowering synchronization. The incompatibility of flowering time can lead to failure in hybridization. Flowering of sugar cane is strongly influenced by photoperiodicity, humidity, temperature, and nutrients (Henry RJ., 2010 & Berding & Roach, 1987) so that for the success of hybridization it is necessary to regulate these factors for flowering time synchronization.

The conventional assembly of sugar cane varieties through hybridization is a long process. This assembly consists of several stages that take more than 10 years (Mamet LD. & R. Domaingue, 1999). The objective of the study was to select potential sugar cane clones produced from potential crosses to dryness of drought resistance. Conventional varieties of sugar cane through hybridization is a long process. Domaingue and Cheero-Nayamuth (1996) suggested that assembling a variety requires several stages that take more than 10 years. Selection of cross-references using family selection systems and individual clones in order to improve selection efficiency in a family-based selection sequence followed by individual clone selection (Cox, et al., 2000; Kimbeng & Cox, 2003; Shanti, et al., 2008). This research is a part or preliminary step to form potential lines in drought conditions.

MATERIALS AND METHODS

The activity held in KP. Karangploso, Malang was conducted from January to December 2016. The material of 52 clones was selected of crossbreed in 2014 (MLG-14) and as a comparison (control of 9 varieties of interdependent and intra-specific elders). The study used a randomized block design of three replicates. 51 selected clones were each planted in a plot consisting of 3 juries of 5 m. The distance of PKP (from center to the center of the segment) was 100 cm. The distance between replicates was 3 m. The seedlings was in the form of one-sided mules (bud set). After the seeds reached 1.5 months they will be elected based on their uniform conditions and were planted in a segment with a distance between plants was 50 cm, so the number of plants per plot was 30 plants. Fertilizer dosage used was 160 kg N + 70 kg P2O5 + 60 kg K2O per ha or equivalent to 800 kg ZA + 200 kg SP36 + 100 kg KCl per ha. SP36 fertilizer was given simultaneously with soil treatment. ZA fertilizer was given 2 times, the first at 7 days after planting as much as 300 kg, and second ZA fertilization of 500 kg ZA was given 1 month after the first ZA fertilization. All doses of KCl fertilizer were given simultaneously with second ZA fertilization. Other crop maintenance included weeding, and pest and disease control was done according to the conditions in the field. Observations were made at the age of 11 months. Parameters observed included plant height, stem length, number of stems/stem, stem diameter, number of segments, intact bar weight, weight and average brix stem weight/m, productive stem volume of seedling, flower appearance and voos on stem. The components of production's requirement must be fulfilled for the measurement in order to avoid biases such as: (1) the height of the stem was measured from the sane soil, if there was difficulty it could be done from the surface of the bundle plus ½ of the height of the bund and starting from the leaf Zero; (2) the number of rods calculated was done by sampling the number of segment/heap example which was usually 10 or adjusted to the circumstances so it could be easier to calculate. It had correlation with the size of the stem diameter, and usually different of each variety (3) the weight of the stem is taken from the sample weight values for analysis, normally up to 3 years / 3 times cut.

RESULTS AND DISCUSSION

The results of the studies in Table 1, 2 and 3 show that the highest parameters compared with the parent for plant height were MLG 14/2/86 (347 cm), MLG 14/2/86, (301 cm), the number of productive stem was MLG 14/2/42 (45 bars), the diameter of stem was VMC 76-16 (39.8 cm), the number of segment was MLG 14/5/15 (27 segment) and ERIANTHUS (27.6), the stem weight was MLG 14/2/44, (2.12 kg), those are used to estimate sugar cane yield either in a visual or calculated manner. From the result of second observation 52 clones and the 9 parent varieties for clone MLG 14/2/86 parameters of plant height (347 cm) and stem length (301 cm), the number of productive clones was MLG 14/2/42, (45 stems), the diameter of stem was (39.8 cm) clone VMC 76-16, the number of segments (26.98 segments) the large of clones was MLG 14/5/15, none of voos on stems was MLG / 4/20 clones (26.6) None and ERIANTHUS varieties (27.6) weight of stems (2.12 kg) of MLG 14/2/44 clones, BL variance.

Table 1 – The height of the crop and the length of clones from the cross

No. Plot	Clone's Name	Height of Crop	Length of Stem	No. Plot	Clone's Name	Height of Crop	Length of Stem
		……… mm ……..				Cm	
1	MLG 14/2/252	302	260	31	MLG 14/2/247	307	269
2	MLG 14/2/259	295	258	32	MLG 14/2/276	279	245
3	MLG 14/2/264	293	259	33	MLG 14/2/253	256	214
4	MLG 14/2/284	320	257	34	MLG 14/2/49	290	243
5	MLG 14/5/20	329	274	35	MLG 14/3/30	257	202
6	MLG 14/1/7	254	202	36	MLG 14/1/6	270	245
7	MLG 14/2/273	266	218	37	MLG 14/2/277	230	194
8	MLG 14/2/44	321	273	38	MLG 14/2/231	258	218
9	MLG 14/2/3A	252	213	39	MLG 14/3/55	338	284
10	MLG 14/2/4	251	214	40	MLG 14/1/8	222	166
11	MLG 14/2/11	288	243	41	MLG 14/1/3	239	184
12	MLG 14/2/12	238	186	42	MLG 14/5/15	225	197
13	MLG 14/2/15	273	222	44	MLG 14/2/17	259	216
14	MLG 14/2/16	250	201	45	MLG 14/4/49	278	226
15	MLG 14/2/9	275	218	46	MLG 14/3/43	249	218
16	MLG 14/2/26	276	234	47	MLG 14/5/3	232	208
17	MLG 14/2/27	284	248	48	MLG 14/2/245	193	163
18	MLG 14/2/52	259	213	49	MLG 14/5/18	253	202
19	MLG 14/2/28	259	213	50	MLG 14/4/20	241	199
20	MLG 14/2/30	308	267	51	MLG 14/2/38	271	243
21	MLG 14/2/32	296	240	52	MLG 14/4/23	264	199
22	MLG 14/2/34	261	212	53	PSDK	242	191
23	MLG 14/2/36	273	223	54	PSJT 941	315	266
24	MLG 14/2/37	288	247	55	PS 881	297	257
25	MLG 14/2/42	275	229	56	PSJK	303	259
26	MLG 14/2/44	272	228	57	VMC 76-16	307	260
27	MLG 14/3/61	319	268	58	GLAGAH	278	213
28	MLG 14/2/66	318	269	59	ERIANTHUS	340	303
29	MLG 14/2/86	347	301	60	CENING	268	214
30	MLG 14/2/241	330	271	61	BL	283	245

For clones MLG 14/2/86 plant the height parameter was (347 cm) and the stem length was (301 cm), the number of productive clones was MLG 14/2/42, (45 bars), the diameter of stem was (39.8 cm) VMC clones 76 -16, the number of segments was (26.98 segments) of voss on the large stem of MLG 14/5/15 clones, MLG / 4/20 (26.6) clones, and ERIANTHUS varieties (27.6) stem weight (2.12 kg) Clone MLG 14/2/44. Hogarth (2005) suggested that one of the selections of high production varieties is by looking at the production of the varieties in a particular environment. Some characters show that the high productivity of sugar cane is the number of tillers and plant height. The character of plant height is strongly influenced by the length of the segment and the number of sections of the weight. Thippeswamy et al. (2003) suggested that there is a positive correlation between sugar cane varieties and the high production of the crude that is affecting the sugar yield. It is closely related to the number of stalks of each clump and the height of the plant.

Table 2 – Number of productive rods, number of segments on stem and average brix value

No. Plot	Clone's Name	Number of Productive Rods	Number of Segments on Stem	Average Brix Value	No. Plot	Clone's Name	Number of Productive Rods	Number of Segments on Stem	Average Brix Value (%)
1	MLG 14/2/252	24	21.8	28.3	31	MLG 14/2/247	28	21.4	28.0
2	MLG 14/2/259	22	25	23.8	32	MLG 14/2/276	34	22.4	25.0
3	MLG 14/2/264	34	24.6	20.8	33	MLG 14/2/253	36	21.4	28.3
4	MLG 14/2/284	35	21.2	23.8	34	MLG 14/2/49	26	21.2	24.8
5	MLG 14/5/20	24	23.6	24.9	35	MLG 14/3/30	29	20.2	27.9
6	MLG 14/1/7	28	20	23.1	36	MLG 14/1/6	31	24.4	13.9
7	MLG 14/2/273	27	19.6	25.9	37	MLG 14/2/277	38	20.4	22.7
8	MLG 14/2/44	23	23.6	29.4	38	MLG 14/2/231	22	23	25.6
9	MLG 14/2/3A	26	23.2	27.0	39	MLG 14/3/55	27	22.4	25.8
10	MLG 14/2/4	35	24.6	24.3	40	MLG 14/1/8	24	20.2	26.2
11	MLG 14/2/11	25	23.6	26.2	41	MLG 14/1/3	31	21.4	21.2
12	MLG 14/2/12	32	17.6	24.2	42	MLG 14/5/15	26	27.1	22.0
13	MLG 14/2/15	23	24.6	24.5	44	MLG 14/2/17	15	24.8	26.3
14	MLG 14/2/16	29	16	20.9	45	MLG 14/4/49	28	26	26.9
15	MLG 14/2/9	23	21.8	21.5	46	MLG 14/3/43	51	23.6	25.0
16	MLG 14/2/26	40	20.8	23.5	47	MLG 14/5/3	15	21	31.9
17	MLG 14/2/27	30	25.2	27.6	48	MLG 14/2/245	5	23	28.8
18	MLG 14/2/52	12	20.8	29.0	49	MLG 14/5/18	15	19.2	32.4
19	MLG 14/2/28	12	20.8	29.0	50	MLG 14/4/20	24	26.6	24.4
20	MLG 14/2/30	15	21.4	23.6	51	MLG 14/2/38	29	21.8	30.6
21	MLG 14/2/32	42	25.6	20.4	52	MLG 14/4/23	4	20	25.9
22	MLG 14/2/34	26	22.6	22.7	53	PSDK	20	18.2	32.3
23	MLG 14/2/36	34	21	21.4	54	PSJT 941	41	20.2	21.7
24	MLG 14/2/37	34	25.8	25.0	55	PS 881	23	21	21.8
25	MLG 14/2/42	45	20	24.4	56	PSJK	21	24.2	26.6
26	MLG 14/2/44	55	23.4	25.7	57	VMC 76-16	26	22	39.8
27	MLG 14/3/61	24	24	24.7	58	GLAGAH	22	12.8	12.0
28	MLG 14/2/66	32	24	23.3	59	ERIANTHUS	43	27.6	16.9
29	MLG 14/2/86	33	26.4	25.6	60	CENING	24	19.6	30.1
30	MLG 14/2/241	36	23.4	25.4	61	BL	36	20.2	21.2

Voos on the stem or the content of the cork on the stem greatly affects the production of brix; the larger the *voos* on the stem, the sugar production will be lower. The *voos* character on the stem has three levels, there are large, small and none. Several parents and clones elected *voos* on the stem begin to large until none, the varieties and clones are: MLG 14/2/86 clones has no *voos* on the stem, MLG 14/2/42 clones has no *voos* on the stem, VMC 76 -16 clone has large *voos* on stem, MLG 14/5/15 clones has no *voos* on stem, MLG / 4/20 clone (26,6) has no *voos* on stem and *ERIANTHUS* varieties have no *voos* on stem, clones MLG 14/2/44 has no *voos* none on stem, BL varieties have small *voos* on stems, MLG clones 14/2/86 has no *voos* on stems, MLG 14/2/42 clones has no *voos* on stem, VMC 76-16 clone has large *voos* on stem, MLG 14/5/15 clone has no *voos* on stem, MLG / 4/20 (26,6) clone has no *voos* on stem and ERIANTHUS varieties have no *voos* on stem, MLG 14/2/44 clone has no *voos* on stem . *Voos* on the stem will appear when the harvest is delayed. Parnidi (2016) suggested that in order to obtain the varieties of sugar cane which do not have "*Voos*" at the time of late cutting, it is necessary to have intensive crosses on sugar cane varieties that have been removed.

The value of brix was observed because it can be used to coarse roughly and inexpensively the sugar content especially for preliminary selection. Hogarth et al. (1981)

suggested that the selection of parents based on general merit could provide a good offspring for brix properties and the amount, length and volume of stem.

Table 3 – Diameter of stem and voos on the stem

No. Plot	Clone's Name	Diameter of Stem cm	Voos on the stem	No. Plot	Clone's Name	Diameter of Stem (cm) mm	Voos on The Stem
1	MLG 14/2/252	28.3	none	31	MLG 14/2/247	28.0	Small
2	MLG 14/2/259	23.8	None	32	MLG 14/2/276	25.0	Small
3	MLG 14/2/264	20.8	None	33	MLG 14/2/253	28.3	None
4	MLG 14/2/284	23.8	none	34	MLG 14/2/49	24.8	Small
5	MLG 14/5/20	24.9	none	35	MLG 14/3/30	27.9	Small
6	MLG 14/1/7	23.1	none	36	MLG 14/1/6	13.9	None
7	MLG 14/2/273	25.9	none	37	MLG 14/2/277	22.7	None
8	MLG 14/2/44	29.4	none	38	MLG 14/2/231	25.6	Small
9	MLG 14/2/3A	27.0	none	39	MLG 14/3/55	25.8	Small
10	MLG 14/2/4	24.3	none	40	MLG 14/1/8	26.2	Small
11	MLG 14/2/11	26.2	none	41	MLG 14/1/3	21.2	Small
12	MLG 14/2/12	24.2	none	42	MLG 14/5/15	22.0	None
13	MLG 14/2/15	24.5	none	44	MLG 14/2/17	26.3	None
14	MLG 14/2/16	20.9	none	45	MLG 14/4/49	26.9	Small
15	MLG 14/2/9	21.5	Small	46	MLG 14/3/43	25.0	None
16	MLG 14/2/26	23.5	Small	47	MLG 14/5/3	31.9	Small
17	MLG 14/2/27	27.6	Small	48	MLG 14/2/245	28.8	None
18	MLG 14/2/52	29.0	Small	49	MLG 14/5/18	32.4	None
19	MLG 14/2/28	29.0	Small	50	MLG 14/4/20	24.4	small
20	MLG 14/2/30	23.6	Small	51	MLG 14/2/38	30.6	none
21	MLG 14/2/32	20.4	none	52	MLG 14/4/23	25.9	none
22	MLG 14/2/34	22.7	none	53	PSDK	32.3	Large
23	MLG 14/2/36	21.4	none	54	PSJT 941	21.7	Small
24	MLG 14/2/37	25.0	none	55	PS 881	21.8	None
25	MLG 14/2/42	24.4	none	56	PSJK	26.6	Large
26	MLG 14/2/44	25.7	none	57	VMC 76-16	39.8	Large
27	MLG 14/3/61	24.7	small	58	GLAGAH	12.0	Large
28	MLG 14/2/66	23.3	none	59	ERIANTHUS	16.9	none
29	MLG 14/2/86	25.6	none	60	CENING	30.1	None
30	MLG 14/2/241	25.4	small	61	BL	21.2	Small

It can be observed on the sugar cane segment, if the sugar cane grows older, the sugar content in each segment increases. If all parts of sugar cane are old, then the sugar level of each segment starting from top to bottom except the shoot is almost none and the sugar reach the highest or maximum level (Sujanto S., 2011). The observation of brix value from 61 clones on the selection of the second stage and 7 parent varieties ranged from 0-24.7%, the parent brix value as follows: PSDK (18.8%), PS 881 (19.4), PSJK (18.8%), VMC 76-16 (16.5%), Glagah (0%), ERIANTHUS (0%), Cening (20%) and BL (24.7%). For clones of cross, the average brix below the parents is BL which can reach 24.7.

CONCLUSION

From the results of the observation on 61 clones of the second and 7th selection of the parent varieties for MLG 14/2/86, the parameter of plant height is (347 cm) and the stem length is (301 cm), the number of productive stem that has no *voos* at MLG 14/2/42 clone is (45 bars), the diameter of stem is (39.8 cm). There is no *voos* on stem at VMC 76-16 clone, the number of segments is (26.98 segments) with *voos* on the large stem. Clone 14/5/15 has no voos on stem, MLG / 4/20 (26.6) clone has no *voos* on stem and the ERIANTHUS varieties (27.6) the weight of the stem is (2.12 kg) and MLG 14/2/44 clone has no *voos* on stem, and the mean brix (24, 7%) *voos* on stem none on BL variety.

ACKNOWLEDGEMENT

We thank the Agency for Research and Development, which has funded and facilitated this research, as well as our gratitude to Ir. Bambang Heliyanto, M.Agr. Ph.D and Abdurrakhman, Sp. as breeders as well as all the parties who helped in this research.

REFERENCES

1. Besse P & L McIntyre 2000. Isolation of an Erianthus sect. Ripidium Specific Ribosomal DNA Spacer Fragment and its Usefulness for Studying Saccharum X Erianthus Introgression Populations in: Sugar cane: Research towards Efficient and Sustainable Production. Wilson JR, Hogarth DM, Campbell JA and
2. Garside AL (Eds). Sugar 2000 Symposium towards a Sweeter Future. Brisbane: CSIRO. pp. 61-63
3. Berding & Roach.1987. Characterisation of Erianthus sect. Ripidium and Saccharum germplasm (Andropogoneae - Saccharinae) using RFLP Marker. Euphytica 93: 283–292
4. Cox MC, TA McRae, JK Bull &DM Hogarth 2000. Family Selection Improves the Efficiency and Effectiveness of A Sugarsugar Cane Improvement Program In: Sugarsugar Cane: Research Towards Efficient And Sustainable Production. Wilson JR, Hogarth DM, Campbell JA and Garside AL (Eds). Sugar 2000 Symposium Towards A Sweeter Future. Brisbane: CSIRO.pp. 42-43
5. Daniels J & BT Roach 1987. Taxonomy and Evolution in: Sugar cane Improvement Through Breeding. Heinz DJ (ed). New York: Elsevier.
6. Ditjenbun. 1916. Luas areal, produksi tebu, rendemen, dan hablur 2005-2016
7. Hadisaputro S, D Ariyani, AR Puspitasari. 2008. Gambaran sekilas kondisi pertanaman tebu giling saat ini dan prediksi produksi gula indonesia tahun 2008 (Not published).
8. Harvey H, AD Hont, K Alix, & B Huckett 1998. Use of PCR-basec Markers ofr Identification of Erianthus Genetic Material in Putative Intergeneric Hybrids (Saccharum X Erianthus). Proc S Afr Sug Technol Ass (72); 318-320.
9. Henry RJ 2010. Basic Information on the Sugar Cane Plant. Genetics, Genomics and Breeding of Sugar Cane. R Henry & C Kole (ed.). Boca Raton: CRC pr.
10. Hogarth, D.M., Wu, K.K. and Heinz, D.J., 1981. Estimating Genetic Variances in Sugar Cane Using A Factorial Cross Design. Crop Sci., 21:21-25.
11. Hogarth, D.M., and N berding, 2005. Breeding for A Better Industry. Conventional breeding Proc. ISSCT XXV jubele Congress. Guatemala. January 30 to Feb 4, 2005.
12. Kimbeng CA & MC Cox 2003. Early Selection of Sugar Cane Families And Clones In Australia: A Review. J Am Soc Sugar cane Technologist (23): 20-39.
13. Marsadi Pawirosemadi.2011. Dasar-Dasar Teknologi Budidaya Tebu dan Pengolahan. Publisher UM Press. p 811; 648-650.
14. Mamet LD & R Domaingue. 1999. Shortening the Selection Process for Sugar Cane. Expl Agric (35): 391-405.
15. OGTR (Office of the Gene Technology Regulator) 2008. Biology of the Saccharum spp. (Sugar cane). The Australian Government, Department of Health and Ageing.
16. Parnidi. 2016. Penurunan kadar gula dan bobot tebu akibat “Voos”. Info Tek. Vol. 7. Number 12. December 2015.
17. Shanti RM, KV Bhagyalaksmi, G Jemaprabha, S Alarmelu, R Nagarajan. 2008. Relative Performance of The Sugar Cane Families in Early Selection Stage. Sugar Tech 10(2): 114-118.
18. Thippeswamy, S., S.T. Kajjidoni,P.M. Salimath, and J.V.Goud.2003. Corelations and Path Analysis for Sugar Cane Yield, Juice Quality and Their Component Traits in Sugarsugar Cane. 65-72.
19. Zang, J, C Nagai, Q Yu, Y Pan, T Ayala-Silva, RJ Schnell, JC Comstock, AK Arumuganathan, & R Ming 2012. Genome Size Variation in Three Saccharum Species. Euphytica