Selection Of Sugarcane Clones From Polycross In Ratoon Cane (Rc)

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Abstract.

Sugar productivity in Indonesia is still low, so it is unable to meet national sugar needs. The use of superior varieties with high productivity is needed to increase sugar productivity. New superior varieties can be obtained through cultivating varieties either by crossing or transgenic methods. The study aimed at evaluating clones resulting from polycross on ratoon cane (RC) with higher crystal yields than their parents (SIL 04). It was carried out at the IP2TP Karangploso Experimental Garden, Sweetener and Fiber Crop Research Institute, Malang, East Java, from January 2021 to December 2021. Eleven crossed clones and one female parent clone (SIL 04) were arranged in a Randomized Block Design with two replications. The results showed 8 clones resulting from the cross (MLG 19/P6/10, MLG 19/P6/11, MLG 19/P6/12, MLG 19/P6/13, MLG 19/P6/16, MLG 19/P6/5, MLG 19/P6/6 and MLG 19/P6/8) produced higher crystal (6.06-7.0 t/ha) than SIL 04 (5.66 t/ha). Improving the crystal structure in the clones resulting from the cross can be done by improving the productivity of sugarcane.

Keywords: *Sugarcane clone, polycross and ratoon (RC).*

I. INTRODUCTION

Sugar is an important commodity for Indonesia, for both public consumption and raw material for the food and beverage industry; the increasing demand occurs due to the increasing population and diversity of food types. Sugarcane (*Saccharum officinarum L.*) is a sugar-producing plant for household consumption, the food and beverage industry, and the pharmaceutical industry (Nurmalasari & Murdiyatmo, 2012). The planted area reached 3,473,230 Ha, with fluctuating white crystal sugar productivity in 2014-2020 (Ditjenbun, 2019). A quite sharp decline of 11.76% occurred in 2015-2016, and 2017 witnessed the lowest productivity of 4,985 kg/ha of white crystal sugar. The highest productivity was achieved in 2020 at 5.5 tons/ha. This productivity has not been able to meet the demand for white crystal sugar, so efforts must be made to increase it. One effort is the use of new superior varieties with high productivity. New superior varieties can be obtained by producing new varieties.

The production of superior sugarcane varieties can be done in two ways: conventionally or unconventionally (transgenic or mutation). Conventionally, the production of new varieties can be done through crossing. Crossing between existing superior varieties aims to combine the superior characteristics of each parent to produce superior varieties with higher productivity than their parents. SIL (Sugar Indo Lampung) 04 is a variety with high crystal production. Clone 6535 is an introduction from Taiwan with high productivity, and the PS 881 variety has a high yield and early maturity. The BL variety has high productivity, resistance to fire injury, and wide adaptability. In 2019, a polycross was carried out between SIL 04 as the female parent with 6535, PS 881, and BL as the male parent. Selection of the cross results resulted in 11 clones producing crystals above the average. In 2020, selection was carried out on 11 clones using the female parents in the first planting of plant cane (PC) as a comparison. Considering that the sugarcane planted in Indonesia is mostly ratoon cane (RC), it is necessary to select the RC planting conditions. Therefore, research was carried out to evaluate clones resulting from polycross in RC, which had higher crystal yields than their parents (SIL 04).

II. MATERIALS AND METHODS

The research was carried out at the IP2TP Karangploso Experimental Garden of the Sweetener and Fiber Plant Research Institute, Karangploso, Malang, East Java, from January 2021 to December 2021.

Meters, calipers, scales, and refractometers were used. Ratoon cane (RC) was used as the material. The planting consisted of 11 clones from crosses and 1 SIL 04 variety as the female parent.

Table 1. The Varieties Used

No.	Names of Varieties
1	MLG/19/P6/10
2	MLG/19/P6/11
3	MLG/19/P6/12
4	MLG/19/P6/13
5	MLG/19/P6/16
6	MLG/19/P6/4
7	MLG/19/P6/5
8	MLG/19/P6/6
9	MLG/19/P6/8
10	MLG/19/P6/9
11	MLG/19/P6/1
12	SIL 04

Plants were arranged in a Randomized Block Design with 2 replications. Each treatment in 1 replication consisted of 2 rows with a length of 5 m. The center-to-center (CTC) distance was 110 cm, so the length of the row per hectare (the row factor) is 8100.Plant maintenance includes fertilizing, weeding, hilling, repairing canals, irrigation, and controlling pests and diseases. Fertilization I was given at the age of 3-4 weeks after ratooning with Phonska fertilizer at a dose of 600 kg/ha, and Fertilization II was given at the age of 3-4 months after ratooning with ZA fertilizer at a dose of 500 kg/ha. Hilling was carried out 2 times after ratooning. Watering was done when the plants looked wilted. Disease control was done by pruning the plant at the base of the stem.Observations of growth variables, including the number of stems per meter of shoot, stem length, stem diameter, and stem weight, were carried out just before harvest. Observations of production variables, including sugarcane productivity, yield, and crystal yield, were carried out at harvest time.Observation of the number of stems per meter of the row was carried out by counting all the production stems in the row. The results were divided by the observed length of the row we obtained data on the number of stems per meter of the row.Stem length was observed by measuring the length of the stem from the base of the stem to the dewlap on each plant sample. Two clumps were taken from each row as plant samples. The stem diameter was measured at the center of the stem of each sample plant.Observation of stem weight was carried out by harvesting all sample plants.

The harvested stems were cleaned of dry leaves and stems, and the tops of the stems were removed. The clean stems were weighed to determine the weight of all sample stems. The stem weight per stem was obtained by dividing the stem weight by the number of sample stems. Sugarcane productivity was observed by harvesting all plants per plot. The clean stems were weighed to determine the stem weight per plot. Sugarcane productivity was calculated by dividing the stem weight per plot by the length of the row per plot and then multiplying by the row factor.The yield was observed by taking 10 samples of the harvested stems to weigh and squeeze. The sap produced in the squeezing process was weighed, and the Brix and Pol values were measured using a refractometer. The extraction factor was calculated by dividing the weight of the sap by the weight of the sample stem. The Brix and Pol values were used to calculate the sap value. The yield was calculated by multiplying the extraction factor by the sap value. The productivity of sugar cane was observed at harvest time by weighing all the harvested stems. Crystal observations were carried out by calculating yield and productivity. All data obtained were then subjected to analysis of variance (ANOVA) and continued with the Duncan test at a 5% level.

III. FINDINGS AND DISCUSSION

Plant Growth

The growth response of sugarcane plants, including the number of stems per meter of the row, stem length and diameter, and stem weight, was influenced by the clones used (Table 1). The clone with the highest number of stems per meter of the row (13.30 stems per meter of the row) was MLG 19/P6/16, and the least (7.23 stems per meter of the row) was MLG 19/P6/1. Comparison with SIL 04 (8.00 stems per meter of the row) showed that 6 clones (MLG 19/P6/10, MLG 19/P6/13, MLG 19/P6/16, MLG 19/P6/6, MLG 19/P6/8 and MLG 19/P6/9) produced a higher number of stems (9.50-13.30 stems per meter of the row), 4 clones (MLG 19/P6/11, MLG 19/P6/12/ MLG 19/P6/ 4 and MLG 19/P6/5) produced the same (8.13-8.43 stems per meter of the row) as SIL 04, and MLG 19/P6/1 produced a lower number of stems (7.23 stems per meter of the row). According to Bashir et al. (2005), the number of sugarcane stems per unit area of land is influenced by plant genetics and the growing environment. In homogeneous growing environmental conditions, the number of sugarcane stems is determined by plant genetics (Naga-Madhuri et al., 2011). This is in accordance with research by Dashora (2012), which shows that genetic differences in sugarcane result in differences in the number of sugarcane stems harvested. A clone that has a greater number of stems per meter of the row than its comparison has the potential to improve the genetic characteristics of the comparison plant.

Table 1. Number of stems per meter of the row, stem length, stem diameter, stem weight

Clone Number	Number of stems per meter of the row		Stem length (cm)		Stem diameter (mm)		Stem weight (kg)	
MLG 19/P6/10	9.80	bc	173.44	bc	21.58	d	0.68	c-e
MLG 19/P6/11	8.28	cd	177.50	a-c	22.58	b-d	0.77	a-d
MLG 19/P6/12	8.17	cd	177.19	a-c	24.17	ab	0.87	ab
MLG 19/P6/13	10.00	bc	153.33	d	23.62	a-c	0.72	b-e
MLG 19/P6/16	13.30	a	143.38	d	22.11	cd	0.59	e
MLG 19/P6/4	8.43	cd	149.58	d	24.23	ab	0.74	b-e
MLG 19/P6/5	8.13	cd	169.06	c	24.83	a	0.88	ab
MLG 19/P6/6	9.00	b-d	191.10	a	23.85	ab	0.92	a
MLG 19/P6/8	10.96	b	187.03	ab	21.40	d	0.72	b-e
MLG 19/P6/9	9.50	b-d	142.03	d	23.63	a-c	0.66	de
MLG 19/P6/1	7.23	d	142.77	d	23.42	a-c	0.66	de
SIL 04	8.00	cd	169.66	c	24.15	ab	0.83	a-c

Numbers accompanied by letters show no significant difference in the Duncan 5% test.

MLG 19/P6/6 had the longest stem length (191.10 cm), and MLG 19/P6/4, MLG 19/P6/9, MLG 19/P6 /1, MLG 19/P6/13, and MLG 19/P6/16 produced the shortest stem length (142.03-153.33 cm). Compared with SIL 04, 5 clones (MLG 19/P6/10, MLG 19/P6/11, MLG 19/P6/12, MLG 19/P6/6 and MLG 19/P6/8) had a longer stem length (173.44 -191.10 cm), and 5 clones (MLG 19/P6/4, MLG 19/P6/9, MLG 19/P6/1, MLG 19/P6/13 and MLG 19/P6/16) were shorter. According to Streck et al. (2010) and Islam et al. (2011), genetic differences in sugarcane plants cause differences in stem length. MLG 19/P6/10 and MLG 19/P6/8 had the lowest stem diameter (21.40-21.58 mm), while the highest (24.83 mm) was MLG 19/P6/5. Compared with SIL 04 (24.15 mm), the results showed that clone MLH 19/P6/5 had a larger stem diameter, 3 clones (MLG 19/P6/12, MLG 19/P6/4 and MLG 19/P6/6) had the same stem diameter, and other clones showed a smaller stem diameter. Stem diameter is determined by the length of the stem and the carbohydrates available for stem growth. The shorter the stem and the more carbohydrates available for stem growth, the bigger the stem diameter obtained (Djumali et al., 2018). According to Menossi et al. (2008) and Rahman et al. (2008), in homogeneous growing environmental conditions, stem diameter is influenced by plant genetics. Hamida et al. (2022) also show the influence of the clones used on the diameter of the sugarcane stem.

MLG 19/P6/6 had the largest stem weight (0.92 kg/stem), while the smallest (0.59 kg/stem) was obtained by MLG 19/P6/16. Compared with SIL 04 (0.83 kg/stem), 3 clones (MLG 19/P6/12, MLG 19/P6/5 and MLG 19/P6/6) had higher stem weight (0.87-0.92 kg/stem), while other clones had lower stem weight. Djumali et al. (2018) state that stem weight is determined by the volume of the stem, which is composed of the cross-sectional area and the length of the stem, where the diameter of the stem can represent the cross-sectional area of the stem, so stem weight can be determined by stem length and diameter. Clones that have a bigger diameter and longer stem length will produce a higher stem weight. In this study, a correlation was obtained between stem weight and stem length and diameter with correlation coefficients of 0.694 and 0.603, respectively. The correlation results mean that the two growth variables are directly proportional to stem weight. Junejo et al. (2010) and Shakoor-ruk et al. (2014) state that the weight of sugarcane stems is determined by the diameter and the length of the stem. According to Ghaffar et al. (2012), if there is no difference in stem length, then stem weight is determined by stem diameter and vice versa. Considering that stem length and diameter are influenced by the clone used, stem weight is also influenced by the clone used. Chohan et al. (2014) show differences in produced stem weight due to differences in the sugarcane clones used.

Plant Production

The response of plant production, which includes sugarcane productivity, yield, and crystal yield, was influenced by the sugarcane clone used (Table 2). The clone that produced the lowest sugarcane productivity (38.53 t/ha) was MLG 19/P6/1, while the highest (57.69-67.01 t/ha) were MLG 19/P6/12, MLG 19/P6/13, MLG 19/ P6/16, MLG 19/P6/5, MLG 19/P6/6 and MLG 19/P6/8. A comparison with the female parent (53.90 t/ha) showed that the 6 clones resulting from the cross produced higher sugarcane productivity than the female parent.Sugarcane productivity is directly proportional to the number of sugarcane stems and weight per stem (Supriyadi et al., 2018). We obtained a correlation between sugarcane productivity and the number of stems and weight per stem with correlation coefficients of 0.633 and 0.286, respectively. The correlation means that these two variables are directly proportional to sugarcane productivity, but the number of stems has a greater influence than stem weight. Abdurrachman et al. (2022a) also state that the number of stems has a greater influence on sugarcane productivity than stem weight. Considering that the number of stems and stem weight are influenced by the clones used, then sugarcane productivity is influenced by the sugarcane clones used. Abdurrachman et al. (2022b) also show the influence of the sugarcane clones used on sugarcane productivity.

Table 2. Yield, productivity, and crystal sugar production

Clone Number	Yield		Productivity		Crystal Sugar Production	
	%		t/ha		t/ha	
MLG 19/P6/10	11.25	a-c	53.97	ab	6.06	a-d
MLG 19/P6/11	11.60	ab	53.49	ab	6.12	a-d
MLG 19/P6/12	11.72	a	57.69	a	6.77	a-c
MLG 19/P6/13	10.89	a-c	58.23	a	6.31	a-d
MLG 19/P6/16	10.53	a-c	65.06	a	6.79	ab
MLG 19/P6/4	10.06	c	50.73	ab	5.06	de
MLG 19/P6/5	10.65	a-c	57.78	a	6.11	a-d
MLG 19/P6/6	10.42	bc	67.01	a	7.00	a
MLG 19/P6/8	10.53	a-c	64.32	a	6.72	a-c
MLG 19/P6/9	10.77	a-c	51.63	ab	5.47	cd
MLG 19/P6/1	10.18	c	38.53	b	3.92	e
SIL 04	10.53	a-c	53.90	ab	5.66	b-d

Numbers accompanied by letters show no significant difference in the Duncan 5% test.

According to Mochtar (2003), yield is the sugar produced from every 1 quintal of sugar cane. Sugarcane yield is determined by sugarcane variety, sugarcane maturity level (age of the sugarcane plant), and the quality of the sugarcane raw material from the time it is in the plantation until it is milled (Marjayanti, 2006). In this study, the highest yield (11.72%) was shown by the MLG 19/P6/12 clone and the lowest (10.06-10.18%) by MLG 19/P6/4 and MLG 19/P6/1 clones. Compared with SIL 04 (10.53%), the results showed that MLG 19/P6/11 and MLG 19/P6/12 produced higher yields (11.60-11.72%), MLG 19/P6/10, MLG 19/P6/13, MLG 19/P6/16, MLG 19/P6/5, MLG 19/P6/8 and MLG 19/P6/9 showed similar yields (10.42-11.25%), while other clones produced lower yields (10.06-10.42%). Abdurrakhman et al. (2020) show that the yield is influenced by the sugarcane clone used.Sugar is a crystal product (sucrose) from sugarcane plants. The resulting crystal grains reflect the interaction of sugarcane productivity with yield. In this study, the highest crystal sugar (7.0 t/ha) was shown by MLG 19/P6/6 and the lowest (3.92 t/ha) was shown by MLG 19/P6/1.

Compared to SIL 04 (5.66 t/ha), 8 clones (MLG 19/P6/10, MLG 19/P6/11, MLG 19/P6/12, MLG 19/P6/13, MLG 19/P6/ 16, MLG 19/P6/5, MLG 19/P6/6, and MLG 19/P6/8) produced higher crystal sugar (6.06-7.0 t/ha) and 3 clones (MLG 19/P6/4, MLG 19/ P6/9 and MLG 19/P6/1) produced lower crystal sugar (3.92-5.47 t/ha). The correlation between crystal sugar production and sugarcane productivity and yield produced correlation coefficients of 0.946 and 0.426, respectively. These results mean that both variables are directly proportional to the crystal sugar production, but sugarcane productivity has a greater influence than yields. Supriyadi et al. (2018) also found that crystal sugar production was determined more by sugarcane productivity than yield. Considering that sugarcane productivity and yield are influenced by the sugarcane clones used, crystal sugar production is also influenced by the sugarcane clones used.

IV. CONCLUSION

From the evaluation of polycrossed clones on ratoon cane (RC), 8 clones (MLG 19/P6/10, MLG 19/P6/11, MLG 19/P6/12, MLG 19/P6/13, MLG 19/P6/16, MLG 19/P6/5, MLG 19/P6/6 and MLG 19/P6/8) produced higher crystal sugar (6.06-7.0 t/ha) than the female parent SIL 04 (5.66 t/ha). Improving the crystal production in the crossed clones occurs by improving sugarcane productivity.

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