Clone Characteristics Of Sil 04, 6535, Ps 881, And Bululawang Polycross

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Abstract.
Indonesia's sugar productivity is low and requires improvement. Producing new superior sugar varieties may increase sugar productivity. In 2019, a polycross between female SIL 04 and male 6535, PS 881, and Bululawang made 11 potential clones. Therefore, it is necessary to determine each clone's characteristics. This research aimed to determine superior clones that generate higher crystal production than the female parents. The research location was the Agricultural Technology Research and Assessment Installation (Instalasi Penelitian dan Pengkajian Teknologi Pertanian - IP2TP) Karangploso from December 2020 until November 2021. The clones and female parents (SIL 04) were arranged in a Randomized Block Design using 2 replications. The research result showed that 9 clones (MLG 19/P6/1, MLG 19/P6/4, MLG 19/P6/5, MLG 19/P6/6, MLG 19/P6/8, MLG 19/P6/9, MLG 19/P6/11, MLG 19/P6/13 and MLG 19/P6/16) produced more crystals (7.07-12.95 t/ha) than the female parents (5.82 t/ha). To sum up, increasing sugarcane productivity improves crystal yields.

Keywords*: Crystal, clone, polycross, productivity and sugarcane.*

I. INTRODUCTION

The soil fertility and climate conditions challenge sugar cane productivity in Indonesia's dry land. The situation, as mentioned earlier, has generated deficient crystal production in the last 5 years (4.98 t/ha) (Ditjenbun, 2020). Producing new superior variety may improve crystal production.New superior sugarcane varieties include SIL 04, PS 881, and Bululawang. However, the varieties did not improve crystal production. Therefore, it is necessary to produce a new superior variety with a higher crystal production. SIL 04 is a sugarcane variety with high productivity and yield and therefore has high crystal production. PS 881 is an early-maturing sugarcane variety with high productivity and yield.

Bululawang is a medium-slow maturing sugarcane variety with high sugarcane productivity and yield. Clone 6535 has high sugarcane productivity. Combining superior traits of 6535, PS 881, and Bululawang into SIL 04 may produce new superior varieties with higher crystal production than the female parents.We performed polycross and created 149 individual plants in 2019. Individual selection of clones was carried out in 2020. Using crystal production as a selection benchmark, we obtained 11 potential clones with above-average crystal production. Furthermore, we conducted a study to determine the superior clones with higher crystal production than the female parents.

II. METHODS AND MATERIAL

The research was conducted at IP2TP Karangploso, Malang, from December 2020 to November 2021. Table 1 presents the soil fertility conditions, and Table 2 shows the rainfall during the study. The planting material was bud chips from 11 polycross clones (SIL 04 x 6535, PS 881, and Bululawang) and one female parent clone as a comparison. The 11 clones were the product of polycross in 2019 and selected in 2020. Furthermore, additional materials were NPK fertilizer, manure, and other chemicals. The tools were measuring tape, scales, caliper, refractometer, and other auxiliary tools.Clones (MLG 19/P6/1, MLG 19/P6/4, MLG 19/P6/5, MLG 19/P6/6, MLG 19/P6/8, MLG 19/P6/9, MLG 19/P6/10, MLG 19/P6/11, MLG 19/P6/12, MLG 19/P6/13 and MLG 19/P6/16) and control variety (SIL 04) were arranged in a randomized block design using 2 replications. Each clone/variety in 1 replication consisted of 1 cross-section with a length of 5 m. The distance from the center to the cross-section center is 110 cm. Therefore, the length of the section per hectare is 8100. We cultivated the sugarcane through replanting, fertilizing, weeding, hilling, repairing canals, irrigation, shedding, and pest and disease control. We replanted dead plants 2 weeks after initial planting until the population became normal. The replanted seeds were of the same quality and variety as the dead plants.We fertilized the plants twice, at 3-4 weeks and 3-4 months after planting. We fertilized the plants in an array at a distance of 10 cm from the base of the stem. We fertilized the plants using 600 kg Phonska and 500 kg ZA. We used Phonska at first fertilization and ZA at second fertilization.

We performed hilling 3 times by pulling the soil around the row to the top. We completed the first and second hilling after fertilization. Furthermore, we performed a third hilling 5-6 months after planting. Irrigation was conducted when the plants were temporarily wilting. We conducted pest control according to the level of attack in the field. We shed or remove dry leaves at the base of the stem depending on plant conditions. During the harvest period, we trimmed shoots and cleaned dry leaves. We collected clean stems according to the plot numbers. Furthermore, we weighed the stem to determine stem weight per plot.We observed the sugarcane before and during harvest. We determined the total stems per m section (JBM) before harvest by counting the number of stems (JB) having a stem length of more than 150 cm and a stem diameter of more than 2.0 cm in all sections. Total stems per m section (JBM) is calculated using the following formula: JBM = JB / (length of the entire section).The stem length, diameter, and weight were observed during the harvest period. We took 10 stems per plot as samples. Each sample was observed for its length and diameter. The stem diameter was observed at the center of the stem. Stem weight was measured by weighing the entire sample plant. The yield was calculated from the pressed sample plants. We measured the sap to determine sap weight, Brix, and pol values.

The extracting factor (FP) is calculated using the following formula:

FP = juice weight/stem weight

Juice value (NN) is calculated using the following formula:

NN = 0.4 x (Brix – pol)

Yield is calculated using the following formula:

Yield (%) = FP x NN

The sugarcane productivity (Protas) and crystal production (Crystal) are calculated using the following formula:

Protas (t/ha) = 8100 x (stem weight per plot) / (total length of all plots)

Crystal (t/ha) = Protas x yield

Table 1. Chemical properties of the experimental soil at IP2TP Karangploso, Malang.

Soil Properties	Value	Category*)
pH 1:1		
- H_2O	5.6	Acid
- KCl 1N	5.3	
C Organic (%)	1.56	Very Low
N total (%)	0.14	Low
C/N	11.0	Low
P_2O_5 Bray ($mg.kg^{-1}$)	3.05	Low
K NH_4OAC1N pH:7 (me/100g)	0.12	Low
Na NH_4OAC1N pH:7 (me/100g)	0.90	Low
Ca NH_4OAC1N pH:7 (me/100g)	15.04	Medium
Mg NH_4OAC1N pH:7 (me/100g)	0.54	Medium
KTK NH_4OAC1N pH:7 (me/100g)	30.60	Medium
Total alkalinity (me/100g)	16.60	Low
Alkali saturation	54	Medium
Texture:		Silty Clay
- Sand (%)	6	
- Silt (%)	45	
- Clay (%)	49	

*) Criterion of Eviati and Sulaeman (2012)

Table 2. Rainfall at IP2TP Karangploso, Malang, during the research

Month	Rainfall (mm)	Total Rainfall (Days)
December 2020	254.8	14
January 2021	355.8	22
February 2021	453.5	20

March 2021	389.3	16
April 2021	191.5	9
May 2021	45.5	3
June 2021	238.0	8
July 2021	14.1	1
August 2021	28.0	4
September 2021	90.0	3
October 2021	202.4	15
November 2021	343.2	23
December 2021	291.1	19

Statistical analysis:

We analyzed data variance. Furthermore, we used Duncan's multiple range test (DMRT) at a 5% level and MSTAT 4.00/EM software. Stepwise regression determined the influence of each component on stem weight, sugarcane productivity, and crystal production.

III. FINDING AND DISCUSSION

Plant Growth

Clones influenced plant growth, such as the length and diameter of sugarcane stems (Table 3). Abu-Ellail *et al.* (2020) and Ali *et al.* (2021) show clone influence on the length and diameter of sugarcane stems. MLG 19/P6/8 influenced MLG 19/P6/4, MLG 19/P6/13, and MLG 19/P6/13. The clones above produced the longest stem (243.93 cm) and the shortest stem length (160.61-172.59 cm). The clones had an average stem length of 187.27 cm, 1.51% shorter than the female parent (190.14 cm). MLG 19/P6/1, MLG 19/P6/6, MLG 19/P6/8, and MLG 19/P6/10 had longer stems than the female parent. Mohammed *et al*. (2019) show that crossed clones produce shorter or longer stem lengths than the parent.

Table 3. Plant growth (stem length and diameter) of sugarcane clones using SIL 04 polycross

Clone	Stem Length (cm)	Stem Diameter (mm)
MLG 19/P6/1	198.19 b-d	24.95 ef
MLG 19/P6/4	164.32 h	32.22 a
MLG 19/P6/5	177.10 fg	27.12 cd
MLG 19/P6/6	202.83 b	26.53 d
MLG 19/P6/8	234.93 a	27.53 cd
MLG 19/P6/9	186.81 d-f	27.13 cd
MLG 19/P6/10	199.92 bc	21.26 g
MLG 19/P6/11	179.25 e-g	28.44 bc
MLG 19/P6/12	183.44 e-g	29.06 b
MLG 19/P6/13	172.59 gh	26.00 de
MLG 19/P6/16	160.61 h	24.24 f
SIL 04	190.14 c-e	22.59 g

Note: Numbers accompanied by the same letter in one column are not different in Duncan's multi-range test at the 5% level.

MLG 19/P6/4 produced the largest stem diameter (32.22 mm). MLG 19/P6/10 and SIL 04 made the smallest stem diameter. The cross clones had an average stem diameter of 26.77 mm, which was 18.52% bigger than the female parent (22.59 mm). However, MLG 19/P6/10 produced a similar stem diameter to SIL 04. Furthermore, crossed clones produced bigger stem diameters than the female parent. Shanmuganathan *et al.* (2015) mention that crossed clones have smaller and bigger stem diameters than the parents.

Sugarcane Productivity Component

Clones influence sugarcane productivity, such as total stem and stem weight (Table 4) Palachai *et al.* (2019) and Rakesh *et al.* (2020) show how clones influence sugarcane weight and total harvested stem. MLG 19/P6/4 and MLG 10/P6/8 obtained the biggest stem weight (1.433-1.504 kg/stem). MLG 19/P6/10, MLG 19/P6/16, and SIL 04 obtained the smallest stem weight (0.765-0.815 kg/stem). The average stem weight was 1.136 kg/stem, which was 39.46% bigger than the female parent (0.815 kg/stem). MLG 19/P6/10 and MLG 19/P6/16 obtained similar stem weights to SIL 04. Getaneh *et al.* (2015) and Biradar *et al.* (2016) show that crossed clones produce bigger or similar stem weights to parents.

Table 4. Components of sugarcane productivity (weight and total stems) of sugarcane clones using SIL 04 polycross.

Clone	Stem Weight (kg/stem)	Total Stem (stem/ha)
MLG 19/P6/1	1.035 ef	80100 cd
MLG 19/P6/4	1.433 ab	77760 cd
MLG 19/P6/5	1.094 d-f	92084 ab
MLG 19/P6/6	1.208 cd	75330 d
MLG 19/P6/8	1.504 a	90113 b
MLG 19/P6/9	1.158 c-e	74057 d
MLG 19/P6/10	0.765 g	83558 c
MLG 19/P6/11	1.222 cd	61560 f
MLG 19/P6/12	1.302 bc	50625 g
MLG 19/P6/13	0.981 f	94255 ab
MLG 19/P6/16	0.794 g	97200 a
SIL 04	0.815 g	67500 e

Note: Numbers accompanied by the same letter in one column mean no difference in Duncan's multi-range test at the 5% level.

Stem weight is influenced by plant growth components such as stem length and diameter (Jun-Luo *et al*., 2014). In this study, the relationship between stem weight (Bbat) and diameter (Dbat), and stem length (Pbat) can be expressed using the following formula: Bbat = 1.7297 Dbat + 0.95064 Pbat – 1.439863 with a correlation coefficient (r) of 0.999. The formula indicates that the effect of stem length and diameter on stem weight is 99.9%. Stepwise regression analysis showed that the influence of stem length on stem weight was 29.4%. In addition, the effect of stem diameter was 70.5%. Therefore, increasing stem diameter would increase crossed clones' stem weight. Mahadevaiah *et al.* (2021) show a positive correlation between stem weight, length, and diameter.MLG 19/P6/13 and MLG 19/P6/16 had the highest number of stems (94255-97200 stems/ha). MLG 19/P6/12 had the least number of stems (50625 stems/ha). Crossed clones produced an average number of 79695 stems/ha, which was 18.07% higher than the female parent (67500 stems/ha). Two hybrid clones (MLG 19/P6/11 and MLG 19/P6/12) produced fewer stems than the female parent. Sarwar *et al.* (2016 dan 2018) reveal that different clones have a different number of stems.

Sugarcane productivity, yield, and crystal production

Clones influence sugarcane productivity, yield, and crystal production (Tabel 5). Naidu *et al*. (2017), Sarol *et al*. (2020), and Mahmood-Ul-Hassan *et al.* (2020) reveal that clones influence sugarcane productivity, yield, and crystal production. MLG 19/P6/8 obtained the highest sugarcane productivity (136.47 t/ha). MLG 19/P6/10, MLG 19/P6/12, and SIL 04 obtained the lowest sugarcane productivity (54.6-65.01 t/ha). The average sugarcane productivity was 89.17 t/ha, which was 63.09% higher compared to the female parent. However, MLG 19/P6/10 and MLG 19/P6/12's sugarcane productivity was similar to the female parent. Bhavana *et al.* (2017a) and Sawar *et al.* (2019) state that crossed clones produce lower or higher sugarcane productivity than the comparison variety.

Table 5. Sugarcane productivity, yield, and crystal production of sugarcane clones using SIL 04 polycross.

Clone	Sugarcane Productivity (t/ha)	Yield (%)	Crystal Production (t/ha)
MLG 19/P6/1	82.91 de	9.88 c	8.21 c-e
MLG 19/P6/4	111.03 b	10.12 b	11.21 b
MLG 19/P6/5	100.92 bc	10.42 a	10.49 b
MLG 19/P6/6	90.54 cd	9.23 e	8.33 cd
MLG 19/P6/8	136.47 a	9.47 d	12.95 a
MLG 19/P6/9	84.61 de	9.17 e	7.75 d-f
MLG 19/P6/10	63.34 fg	9.64 d	6.11 gh
MLG 19/P6/11	74.19 ef	9.53 d	7.07 e-g
MLG 19/P6/12	65.01 fg	10.53 a	6.87 f-h
MLG 19/P6/13	91.57 cd	10.18 b	9.33 c
MLG 19/P6/16	80.30 de	9.53 d	7.68 d-f
SIL 04	54.68 g	10.65 a	5.82 h

Note: Numbers accompanied by the same letter in one column mean no difference in Duncan's multi-range test at the 5% level.

The number of stem and stem weights influences sugarcane productivity. In this study, the relationship between sugarcane productivity (Protas), the number of stems (Jbat), and stem weight (Bbat) can be written using the following equation Protas = 0.85367 Jbat + 0.90621 Bbat -0.726949 with a correlation coefficient (r) of 0.993. The formula indicates that the number of stems and weight influences productivity by 99.3%. Based on stepwise regression analysis, the influence of the number of stems on sugarcane productivity is 42.1%, and the influence of stem weight on sugarcane productivity is 57.2%. Therefore, increasing the number of stems and stem weight improves sugarcane productivity. Palachai *et al.* (2019) and Ogunniyan *et al.* (2020) show a positive correlation between sugarcane productivity, the number of stems, and stem weight. The crossed clones produced an average sugarcane yield of 9.79%, which was 8.10% lower than the female parent (10.65%). Two clones (MLG 19/P6/5 and MLG 19/P6/12) had similar sugarcane yield to the female parent.

Khurshid *et al.* (2020) and Afzal *et al.* (2021) reveal that crossed clones produced identical or lower yields to the comparison variety.MLG 19/P6/8 had the highest crystal production (12.95 t/ha). MLG 19/P6/10, MLG 19/P6/12, and SIL 04 had the lowest crystal production (5.82-6.87 t/ha). The crossed clones produced an average crystal production of 8.73 t/ha, which was 50.03% higher than the female parent (5.82 t/ha). MLG 19/P6/10 and MLG 19/P6/12 had similar crystal production to the female parent. Bhavana *et al*. (2017b) and Ali *et al.* (2020) show that clones produce equal or higher crystal production to the comparison variety.Sugarcane productivity and yield influence crystal production. In this study, the relationship between the crystal production (Hablur), sugarcane productivity (Protas), and yield (Rend) can be written in the following equation Hablur = 1.0393 Protas + 0.65792 Rend – 0.6111162 with a correlation coefficient (r) of 0.999. The formula indicates that sugarcane productivity and yield influence crystal production by 99.9%. Stepwise regression analysis showed that sugarcane yield influenced crystal production by 8.0%, and sugarcane productivity influenced crystal production by 91.9%. Therefore, increasing sugarcane productivity and yield improves crystal production. Hassan *et al.* (2017) and Khan *et al.* (2021) show a positive correlation between crystal production, sugarcane productivity, and yield.

IV. CONCLUSION

Based on the research result, 9 clones (MLG 19/P6/1, MLG 19/P6/4, MLG 19/P6/5, MLG 19/P6/6, MLG 19/P6/8, MLG 19/P6/9, MLG 19/P6/11, MLG 19/P6/13 and MLG 19/P6/16) produced higher crystal production (7.07-12.95 t/ha) than the female parent (5.82 t/ha). Increasing sugarcane productivity will improve crystal production.

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