Agro-Physiological Response of Phil 2011-0237, Phil 2011-0899, Phil 2011-1683 and Phil 2011-1121 under Waterlogged Condition Imposed at Tillering and Stalk Elongation Stage

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ABSTRACT

The study aimed to determine the yield performance of the varieties (Phil 2011-0237, Phil 2011-0899, Phil 2011-1683 and Phil 2011-1121) under natural waterlogged condition for its cultural packaging. The study was conducted at the La Granja Agricultural Research and Extension Center, La Granja, La Carlota City (latitude of N 10^0 24.492' and longitude of E 122^0 59.388') on May 2021 to October 2022. Four promising varieties were laid out following a Split-plot in Randomized Complete Block Design in four replicates and evaluated for their growth and yield performance under waterlogged soil condition. Waterlogged stress was imposed during the tillering and stalk elongation stage.

Phil 2011-1683 and Phil 2011-0899 relatively have the highest cane yield (115.33 t ha^1); 100.43 t ha during the tillering stage while the highest cane yield during the water stagnation in stalk elongation stage was obtained by Phil 2011-1683 (118.76 t ha^1), Phil 2011-0899 (118.09 t ha^1), followed by Phil 2011-0237 with 103.32 t ha^1).

Varietal differences were observed in terms of no. of tillers, plant height, relative leaf greenness, stomatal conductance, cane yield, and sugar yield at tillering and stalk elongation stage while there was no significance observed among varieties in terms of plant height (3 & 6 months) during the stalk elongation stage.

Keywords: Waterlogged condition; tonnage; stomatal conductance, tillering stage; stalk elongation stage

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Introduction

Nowadays, climate change is a major limiting factor affecting crop productions in different areas of the globe. Sugarcane, a widely cultivated perennial crop contributing to the worlds industry is experiencing adverse climatic conditions such water deficit and flooding conditions. Climate change may projected to result in floods in some areas of the year. Since floods result in waterlogging conditions, salinity and raised water table, reduce yields significantly (Glaz et al., 2004). The average yield loss due to waterlogging is estimated to be 15 – 25 % and can exceed 40 % depending on the magnitude of stress (Gomathi and Chandran, 2009). The study of (Manoharan et al., 1990), indicated that water stagnation for two months lead to reduction in cane yield to the tune of 26 – 36 % in various variety. Gomathi and Chandran, 2009 observed 45.6 % reduction in single cane weight, 30 % reduction in stalk length, 15.9 % reduction in intermodal length, 17.8 % reduction in cane yield.

High tolerance to waterlogging or flooding can improve plants ability to survive in the environmental condition (Sholeh Avivi1, et al., 2020), it is therefore important to adapt sugarcane production to such conditions. Hence, the current study focused on evaluating the resiliency of four high yielding sugarcane varieties to natural waterlogging field condition at SRA La Granja, La Carlota, Negros Occidental.

The study seeks the following objectives:

1. To evaluate the agro-physiological performance of four (4) High Yielding Varieties (HYVs) of sugarcane under natural waterlogged condition during tillering and stalk elongation stage.

2. To determine the resiliency for four Phil 2011 series under waterlogged condition.

Methodology

The field trial on the response of sugarcane high yielding varieties to natural waterlogging condition was established during May 2021 - 2022 cropping season at SRA – La Granja Experimental station, La Carlota City, Negros Occidental under clay – loam soil type. Four SRA released sugarcane high yielding varieties were used in the study. The study was then laid out in a Split-plot in Randomized Complete block Design (RCBD) composed of 4 replication and naturally imposed to waterlogging condition during tillering (3 months) and 6 months after planting (Stalk elongation stage). Parameters gathered during grand growth stage were; tiller count, plant height (cm), relative leaf greenness, and stomatal conductance.

The field trial was terminated during 12 months from planting. The parameters gathered were; stalk length (cm), stalk diameter (cm), number of millable stalks, and cane yield per plot. Along the harvesting period, a total of 10 samples stalks per variety in each plot were obtained and subjected to juice analysis.

Data were then consolidated and subjected to statistical analysis via Statistical Tool for Agricultural Research Analytical software.

Results

Total cumulative rainfall, Average relative humidity, and mean temperature throughout the cropping season reached up to 2,735.4 mm rainfall, 79.12 % average RH, and 26.99 % mean temperature, respectively (Figure 1). Consecutive higher rainfall appeared during stalk elongation (grand growth stages) of sugarcane ranging 5 mm to 120 mm from mid – May to august and frequently distributed throughout the maturity stage of the crop. Average mean temperature and average relative humidity during stalk elongation stage ranged 27.39 % mean temperature and 82.11 % RH. With the absence of soil moisture monitoring on the actual field, the figure below can be explained that the sugarcane are experiencing flooding during the grand growth stages of sugarcane (appeared at exactly 3 and 6 months from planting) under clay – loam soil type.

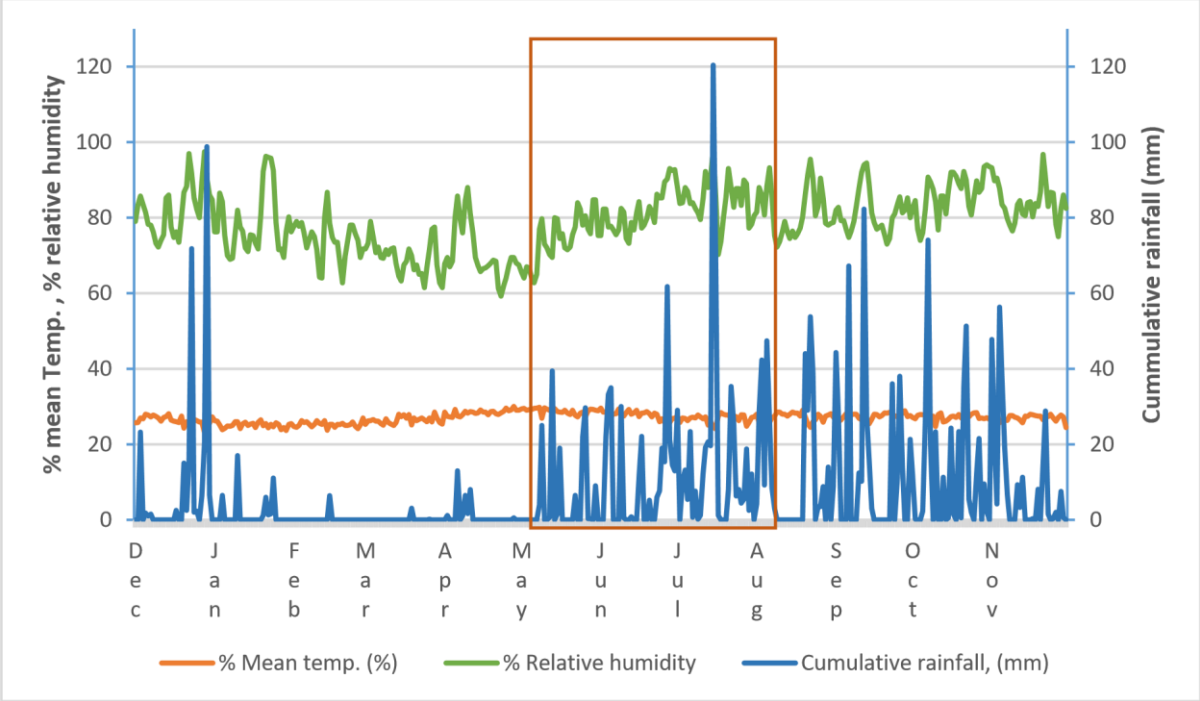

Figure 1. Monthly distribution of cumulative rainfall (mm), Relative humidity (%), and Mean temperature (%) based on Agro – meteorological weather forecast station, Brgy. La Granja, La Carlota City.

The results of the study only showed varietal differences among 4 sugarcane HYV's in terms of plant height during the early waterlogging period (Table 1). Significantly higher plant height means were observed on Phil 2011-1683 (77.47cm), Phil 2011-0899 (69.60 cm) and Phil 2011-1121(61.65 cm), while Phil 2011-0237 got the lowest mean of 33.00 cm. Plant height mean among varieties at six (6) months after planting varied from 165.25 cm to 219.73 cm. On the other hand, no varietal differences found among 4 sugarcane HYV's in terms of plant height at three (3) and six (6) months after planting during the stalk elongation period. Plant height mean among varieties varied from 53.00 cm-67.47 cm; 185.35 cm-231.45 cm. respectively.

On the other side, varietal differences were observed among varieties in terms of number of tillers (Table 2). The number of tillers among varieties varied significantly with tiller count means of 6.36 during 3 months after planting. Phil 2011-1683 had the highest tiller count means of 8.05 followed by Phil 20110899 with tiller count means of 6.24, followed by Phil 2011-1121 with 6.00 while the lowest was obtained by Phil 2011-0217.

Varietal differences were also observed in terms of cane yield both in tillering and stalk elongation stage (table 3). The average cane yield of four varieties during tillering stage presented 95.76 t ha^{-1} with

Phil 2011 – 1683, Phil 2011 – 0899, and Phil 2011 – 1121 having the highest cane yield mean of 115.33, 100.43, and 94.27 t ha^{-1} while Phil 2011-0237 – have the lowest cane yield mean of 72.99 t ha^{-1}. Water stagnation during stalk elongation stage also showed significant variations among test varieties, highest cane yield was obtained by Phil 2011-1683, Phil 2011-0899 and Phil 2011-0237 with comparable mean cane yield of118.76 t ha^{-1}, 118.09 t ha^{-1}, and 103.32 t ha^{-1} respectively, while the lowest cane yield was obtained by Phil 2011-1121 with 75.39 t $ha^{-1.}$

In terms of sugar yield, three varieties maintained higher yield during water stagnation at tillering stage with Phil 2011 – 1683, Phil 2011-0899, and Phil 2011 – 1121 having significantly highest sugar yield means of 250.97, 232.27, and 214.18 lkg/ha respectively, whereas Phil 2011 – 0237 got the lowest mean of 164.16 lkg/ha. At stalk elongation stage, significantly higher sugar yield was obtained by Phil 2011-1683, Phil 2011-0899 and Phil 2011-0237 with mean sugar yield of 264.82, 240.90, and 240.74 LKg/Ha, while Phil 2011-1121 had the lowest sugar yield mean of 175.81 LKg/Ha (Table 4).

Physiological traits

Water regime showed significant differences on SPAD value (Table 5A). Result showed that water stagnation during tillering stage had significantly lower values compared to treatments at stalk elongation stage. It was observed that highest relative leaf greenness of 46.06 was obtained by varieties tested at stalk elongation stage while the lowest was obtained at tillering stage with numeric values of 40.27.

Waterlogging showed positive effect on stomatal conductance among varieties (Table 5B). Water stagnation at tillering stage showed significantly lower values of 249.43, while higher stomatal conductance readings were observed on the varieties at stalk elongation stage.

Juice quality measured in terms of brix (% total soluble solids), % polarity of sucrose, % apparent purity of sucrose and sugar rendement (lkg tc^{-1}) showed no significant differences among varieties under waterlogged condition at tillering and talk elongation stage (table 6). Sugar rendement (LKg/TC) of four varieties ranged from 2.18-2.30 LKg/TC; 2.04-2.33 LKg/TC respectively.

Discussions

Water stagnation for two months lead to reduction in sugar yield as a result in reduction in cane yield (Manoharan et al., 1990). In relation to our study, the study of (Carter and Floyed, 1974: Carter 1976) indicated that higher water table during active growth phase adversely affects stalk weight and plant population resulting in yield loss at the rate about one ton per acre for one inch increase in excess water. The results of (R. Anitha et al., 2016) indicated higher reductions on plant height and stalk diameter of 7.22

% and 16.3 % during grand growth under waterlogging area while there was an increased in number of nodes under waterlogging condition of 14.8 % in contrary with our study. Gomathi and Chandran (2009), reported yield loss due to waterlogging reached up to 15 – 25 % and can exceed 40 % depending on magnitude of stress.

Table 1. Morphological characters (plant height) of sugarcane high yielding varieties in response to waterlogging condition during tillering and stalk elongation stage.

HYV Variety	Tillering Stage		Stalk Elongation Stage	
	3 months	6 months	3 months	6 months
Phil 2011-0237	33.00[b]	165.25	53.00	185.35[b]
Phil 2011-0899	69.60[a]	208.77	59.60	223.27[a]
Phil 2011-1683	77.47[a]	219.73	67.47	231.45[a]
Phil 2011-1121	61.65[a]	192.30	61.65	202.45[a]
CV	18.84	10.22	9.46	11.49
Mean[-1]	60.43*	196.51 ns	60.43ns	210.63ns

Means fallowed by the same letter are not significantly different at p > 0.05 level.

Table 2. Morphological characters (number of tillers) of sugarcane high yielding varieties in response to waterlogging condition during tillering and stalk elongation stage.

HYV Variety	Tillering stage	Stalk elongation stage
Phil 2011-0237	5.25[b]	6.32
Phil 2011-0899	6.24[a]	8.09
Phil 2011-1683	8.05[a]	8.76
Phil 2011-1121	6.00[ab]	5.39
CV	14.27%	13.43%
Mean	6.36*	7.14ns

Means followed by the same letter are not significantly different at p > 0.05 level.

Table 3. Sugarcane tonnage (TC/HA) of selected high yielding varieties at tillering and stalk elongation stage).

HYV Variety	Tillering stage	Stalk elongation stage
Phil 2011-0237	72.99[b]	103.32[a]
Phil 2011-0899	100.43[a]	118.09[a]
Phil 2011-1683	115.33[a]	118.76[a]
Phil 2011-1121	94.27[ab]	75.39[b]
CV	14.27%	13.43%
Mean	95.76*	103.89*

Means followed by the same letter are not significantly different at p > 0.05 level.

Table 4. Sugar yield (LKg/HA) of selected high yielding varieties at tillering and stalk elongation stage).

HYV Variety	Tillering stage	Stalk elongation stage
Phil 2011-0237	164.16[b]	240.74[a]
Phil 2011-0899	232.27[a]	240.90[a]
Phil 2011-1683	250.97[a]	264.82[a]
Phil 2011-1121	214.18[ab]	175.81[b]
CV	14.44%	15.20%
Mean	215.40*	230.57*

Means followed by the same letter are not significantly different at p > 0.05 level.

Table 5. Varietal differences among 4 sugarcane HYV's on different physiological traits tested at tillering and stalk elongation stage.

Treatment	SPAD (A)	Stomatal conductance (B)	Sugar rendement (C)	Sugar yield (D)
	-	mmol/m2/s	LKG/TC	LKG/HA
Water Regime				
Tillering stage	40.27 b	249.43 b	2.25	215.40
Stalk elongation stage	46.06 a	259.99 a	2.24	230.57
CV	17.96	27.77	4.83	17.43
Mean	43.16	254.71	2.25	242.45

Means followed by the same letter are not significantly different at p > 0.05 level.

Table 6. Sugar yield (LKg/TC) of selected high yielding varieties under waterlogged condition at tillering and stalk elongation stage).

HYV Variety	Tillering stage	Stalk elongation stage
Phil 2011-0237	2.24	2.33
Phil 2011-0899	2.30	2.04
Phil 2011-1683	2.18	2.24
Phil 2011-1121	2.28	2.33
CV	8.43%	11.18%
Mean	2.25	2.24

Means followed by the same letter are not significantly different at p > 0.05 level.

Conclusions

This study set out to determine the resiliency of four sugarcane high yielding varieties from Phil 2011 series under waterlogging conditions. The results of this study indicated that:

1. Varietal differences were observed in terms of no. of tillers, plant height, relative leaf greenness, stomatal conductance, cane yield, and sugar yield at tillering and stalk elongation stage while there was no significance observed among varieties in terms of plant height (3 & 6 months) during the stalk elongation stage
2. Phil 2011-1683 and Phil 2011-0899 relatively have the highest cane yield (115.33 t ha^{1}); 100.43 t ha during the tillering stage while the highest cane yield during the water stagnation in stalk elongation stage was obtained by Phil 2011-1683 (118.76 t ha^{1}), Phil 2011-0899 (118.09 t ha^{1}), followed by Phil 2011-0237 with 103.32 t ha^{1}).

Recommendations

The evidence from this study recommends that further study for confirmatory trial should be done for waterlogging tolerance. It could also be recommended to obtain more morpho – physiological traits to highly determined waterlogging tolerance among varieties.

References

Glaz, B., D.R. Morris, and S.H. Daroub. 2004a. Sugarcane photo- synthesis, transpiration and stomatal conductance due to flooding and water table. Crop Science 44: 1633–1641.

Glaz, B., D.R. Morris, and S.H. Daroub. 2004b. Periodic flooding and water table effects on two sugarcane genotypes. Agronomy Journal 96: 832–838.

Gomathi, R., and K. Chandran. 2009. ‘‘Effect of waterlogging on growth and yield of sugarcane clones’’. Sugarcane Breeding Institute (SBI-ICAR). Quarterly News Letter 29(4): 1–2.

Krishna, B., Kamat, D.N., 2018. Evaluation of Sugarcane (Saccharum officinarum L.) Mid-late Clones Under Waterlogging Conditions of Bihar (India). Applied. Bio. Re. 20 (1), 55-61.

Manoharan, M.L., K. Duraisamy, S.V. Krishnamurthy, H. Vijayara- ghan, and K. Muthkrishnan. 1990. Performance sugarcane varieties in waterlogged condition. Maharastra Sugar 15(11): 39–45.

Sholeh Avivi1, et al., 2020. Tolerance screening of sugarcane towards waterlogging stress. E3S Web of Conferences 142, 03007 (2020) ICALS 2019.