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Determination of the Best Performing Sri Lankan Maize Accessions Based on the Photosynthetic, Biomass and Yield Traits

M.M.M. Mufeeth, A.N.M. Mubarak* and A.D.N.T. Kumara

Department of Biosystems Technology, Faculty of technology, South Eastern University of Sri Lanka, University Park, Oluvil, #32360, Sri Lanka

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Mubarak, A.N.M
https://orcid.org/ 0000-0002-1703-8609

ABSTRACT

Maize (*Zea mays* L.) is one of the most widely cultivated cereal crops throughout the world and is extensively grown in Sri Lanka. Information on the photosynthetic, biomass and grain yield of local maize accessions are useful for plant breeding programs. However, due to the scarcity of such information, this study aimed to investigate the potentials of maize accessions to select the best performers utilizing the rank summation and selection index criteria. As the first step, the seeds from 14 maize accessions along with two varieties *viz*; Pacific-999 and Bhadra (control) were established in the field. The leaf-level photosynthetic and chlorophyll fluorescence traits were analyzed, while biomass and yield traits were obtained at harvest, by employing standard techniques. Our findings revealed that traits related to growth, photosynthesis, and biomass showed greater variations among the maize accessions tested. The number of days taken to 50% flowering (44d-60d), photosynthetic rates (19.7-30.45 μmol CO_2 m^{-2} s^{-1}), transpiration rates (2.45-4.52 mmol H_2O m^{-2} s^{-1}), water use efficiency (5.69-8.13 μmol CO_2 mmol H_2O^{-1}), and maximum quantum yield (0.68-0.73) among the tested accessions. Additionally, the variations in biomass (111.0-459 g/plant) and final cob yield (38-232 g/cob) were also seen among the maize accessions. According to rank summation index analysis, the maize accessions SEU2, SEU16, SEU15, SEU9 and SEU10 were superior in terms of photosynthetic rates, biomass and yield compared exhibiting with the lowest RSI values of 71, 100, 101, 103 and 117, respectively, than the cv. Bhadra. Therefore, future crop development programs can make use of these five potential maize accessions identified through this study.

*Corresponding author- anmubarak@seu.ac.lk

INTRODUCTION

Maize (*Zea mays* L.) is one of the most widely cultivated cereal crops in the world, preceded by rice and wheat (FAOSTAT, 2021). It primarily serves the production of food, feed sectors, and biofuels (Huma et al., 2019). Maize can be grown as cereal, fodder, and grain crops in tropical, temperate, and semi-arid regions, using both flooded and rainfed farming systems (Alvi et al., 2003). In the year 2020, approximately 63,450 ha of land were under maize cultivation in Sri Lanka during the *Maha* and *Yala* seasons, with an annual total production of 245,647 tons. Maize is predominantly cultivated in the districts of Anuradhapura, Ampara, Badulla, Monaragala, Matale, and Batticaloa. Moreover, maize germplasm exhibits a larger genetic variability, with over 28,000 distinct seed collections reported to exist globally (O'Leary, 2016). Sri Lanka has approximately 819 maize germplasm varieties, of which 35 are local maize accessions (Kumari et al., 2017). A recent study revealed that Sri Lankan maize accessions exhibit a wide diversity in morphological, canopy architectural, and biomass characteristics (Mufeeth et al., 2020). In terms of crop productivity, efficiency is primarily influenced by the capacity of shoots and roots to capture and convert resources into biomass, as well as the degree to which biomass is partitioned into harvestable products (Wu et al., 2016).

To meet the growing need for food, it is essential to identify unique photosynthetic features in crops (Guidi et al., 2019). The physiological processes that lead to crop production start with CO_2 diffusion via the stomata into the intercellular spaces and end with CO_2 assimilation (Taiz et al., 2015). Maize strictly adheres to the C_4 photosynthetic pathway, which includes the specialized Kranz architecture. Several attempts have been made to create methods for identifying photosynthetically-efficient plants among populations of maize (Nasar et al., 2021) and other cereal crops, such as rice (Mubarak et al., 2022; Nagoor, 2013), wheat (Gaju et al., 2016), and barley (Sadura et al., 2019). Moreover, the recent approach using chlorophyll fluorescence measurements, which partially unravels the thylakoid membrane ultrastructure, has aided in the investigation of both photosystems I and II, their organization, energy transfer, and photochemistry. Thus, these techniques assist in measuring various plant stresses (Murchie and Lawson, 2013). Such techniques have been viewed as robust and widely employed in a variety of genotypes (Ajigboye et al., 2017) and can be used to identify superior germplasms for breeding purposes.

Maize breeders need to simultaneously enhance targeted features related to photosynthesis, biomass, and yield attributes without affecting the overall crop growth. One method of identifying plant germplasms for numerous qualities at once is through index selection (Okoli, 2021). The rank-summation index (RSI) was suggested by Mulamba and Mock (1978) as a method for identifying the top-performing cultivars. The rank-summation index is calculated by ranking each cultivar according to each trait and then summing the trait ranks for each cultivar. The cultivars with the lowest index values are selected for future use.

RSI offers numerous benefits, including its simplicity and the absence of the requirement for estimates of genetic and phenotypic components (Hallauer and Carena, 2009). The notion of RSI has been applied in numerous studies, including those on the simultaneous selection of yellow passion fruit progeny (Okoli, 2021), stem borer resistance in maize (Oloyede-Kamiyo, 2019), and the agronomic performance of drought-tolerant maize hybrids (Rosado et al., 2012). Therefore, the RSI approach can be used in Sri Lanka to identify new maize genotypes with improved traits.

Hence, it becomes necessary and warranted to elucidate the latent potentials of local landraces and focus on photosynthesis, biomass, and yield, which are vibrant in the current context of global food security. Therefore, this research aimed to investigate the photosynthetic traits among different maize landraces and evaluate biomass and grain yield traits using the rank summation index to identify the best landraces for crop improvement programs.

METHODOLOGY

Experimental location

The research was carried out at the farm facilities in Malwatta (7°20'N and 81°44'E, altitude of 16.0 m above sea level) of the Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka from January to December 2021. The experimental site is characterized by sandy loamy soils with an average monthly rainfall of 127.1 mm and a temperature of 30.3 °C. The site is located in the dry zone and falls within the agroecological region DL2 (Mubarak et al., 2022).

Plant material, growth conditions, and experimental design

The field layout was designed in a Randomized Complete Block Design (RCBD) with 10 replicates, and each plot was sized at 1.5 m × 3.0 m. The hybrid maize variety Pacific-999, imported from Thailand, was included along with fourteen high-performing local maize accessions, namely, SEU2, SEU6, SEU9, SEU10, SEU14, SEU15, SEU16, SEU17, SEU18, SEU19, SEU20, SEU21, SEU22, SEU23, and the variety Bhadra (control) (Table 1). The selected local maize accessions exhibited early flowering (<55d), a higher leaf area index (> 1.8) at vegetative stages, and improved cob characteristics compared to the control plants under field conditions (Mufeeth et al., 2020). The seeds of the selected maize accessions were sown at a spacing of 30 cm x 60 cm. The field was then maintained as described by Mufeeth et al. (2020).

For each maize accession, the average number of days to reach 50% tassel emergence was recorded (D50%). Subsequently, at the tasseling stage (6 weeks after planting, WAP), the photosynthetic rates, chlorophyll fluorescence, and leaf area index were measured by sampling five plants from each field plot to estimate the mean response of each maize accession, as described below. This particular plant stage was selected as most of the maize germplasm shifted from their vegetative to the reproductive stage (at 6 WAP) and tended to exhibit increased rates of plant photosynthesis. Finally, the individual plant biomass and yield traits were recorded at 15 WAP.

Photosynthetically-active radiation and leaf area index measurements

Non-destructive field leaf area index (LAI) measurements were performed six weeks after field planting (6 WAP) by considering three rows from each field plot. A ceptometer (AccuPAR, LP-80, Meter Group Inc, USA) was used to measure photosynthetically-active radiation (PAR) (Pokovai and Fodor, 2019). Prior to field measurements, the device was calibrated following the manufacturer's instructions using the PAR sensor when the solar radiation was greater than 600 µmols m^{-2} s^{-1}. Thereafter, the PAR above the crop canopy was measured with an external light sensor (Apogee SQ110, USA), and the PAR received at the bottom of the canopy was measured using the probe (80 cm) of the ceptometer. The LAI was estimated in the above stage using the leaf distribution parameter (χ) and the ratio of below and above canopy PAR levels (Francone et al., 2014).

Leaf chlorophyll fluorescence parameters and chlorophyll content

A portable fluorometer (FluorPen FP 100; Photon Systems Instruments; Drasov, Czech Republic) was used to measure the maximum quantum yield of photosystem II (PSII) at light (Qy_{light}) and dark (Qy_{dark}). The flash pulse of the blue light LED emitter (455 nm) was set to 30% with the maximum intensity set to 3,000 µmol m^{-2} s^{-1}. The same leaves were covered with aluminum foils for 30 minutes to measure Qy_{dark} (Naidoo and Naidoo, 2018). The leaf chlorophyll content in the SPAD unit was measured using SPAD 502 Plus (Konica Minoltkoptics Inc, USA).

Leaf gas exchange parameters

The net CO_2 assimilation rates (A_N) (µmol CO_2 m^{-2} s^{-1}), intercellular CO_2 levels (Ci) (µmol CO_2 m^{-2} s^{-1}), transpiration rates (E) (mmol H_2O m^{-2} s^{-1}), and stomatal conductance (gs) (mmol H_2O m^{-2} s^{-1}) were measured using an Infrared Gas Analyzer (LI-6800, LI-COR, Nebraska, USA) portable photosynthesis system. Intrinsic water use efficiencies (WUE) were then calculated following the method described by Feldman et al. (2017). At the tasseling stage, the youngest fully expanded leaves were clamped into a chamber with an area of 36 cm^2, and A_N measurements were taken at a leaf temperature of 30 °C, airflow rates of 600 µmol s^{-1}, and 70% relative air humidity. All parameters were measured between 9:00 am and 12:00 noon on clear, cloudless days to ensure that the plants were in an active photosynthetic state while minimizing light acclimation.

Above-ground dry mass and yield components

The physiological maturity of maize crops was determined between 55 to 65 days after silking by checking for the formation of the black layer at the tip of the kernels. Once the plants reached their stage of physiological maturity, three randomly selected plants from each plot were chosen and cut at ground level. The number of developed cobs per plant was recorded (NC_{plant}). The individual cob length (CL), number of kernels per cob (NK_{cob}), and 100-kernel weight (KW_{100}) at a moisture level of 12% were measured. To determine the above-ground biomass (AGDM), the plant parts were divided into stems and cobs (CW) and oven-dried at 80 °C until a constant dry weight was achieved.

Statistical Analysis

To assess the normal distribution of plant trait data related to canopy architecture, physiology, biomass, and yield parameters, the Shapiro-Wilcoxon test was performed using SPSS software after removing the outliers. The rank summation index (RSI), as described by Mulamba and Mock (1978), was then used to identify the superior local maize accessions. The RSI was calculated by summing the rankings of each trait for each cultivar/accession, and those with the lowest RSI values were assigned the lowest selection index (SI) values, indicating their superiority among the maize accessions. The rankings (R1-R16) of each maize accession for each characteristic were used to calculate the RSI.

RESULTS AND DISCUSSION

Ranking of maize plant growth parameters

Our investigation revealed significant variation in the canopy leaf area index (LAI) among the tested maize accessions. A higher LAI theoretically enhances the capture of incident solar radiation, leading to increased photosynthetic rates. Therefore, in the RSI method, the maize accessions with the lowest rank numbers were considered the best performers (Table 1). Pacific-999 and SEU17 ranked 1st, while SEU2 and variety Bhadra ranked 3rd, showing the highest mean LAI. Additionally, the time taken to reach 50% flowering (D50%) was evaluated as a positive characteristic. Accession SEU2 exhibited the lowest D50% and ranked 1st (44 days), while Pacific-999 and Bhadra ranked 2nd. Among the treatments, SEU19 displayed late flowering (60 days).

Ranking of leaf photosynthetic traits of maize

The evaluated maize accessions also exhibited noticeable variations in leaf-level photosynthetic traits. The selection criteria favored the accessions with the highest scores for Qy_{light}, Qy_{dark}, and chlorophyll content of leaves. SEU21 displayed the highest quantum yield in the presence of light (Qy_{light}), followed by SEU18 and SEU23, respectively (Table 2). Conversely, the highest quantum yield (Qy_{dark}) of leaves with dark adaptation was observed in Pacific-999 and SEU2 (ranked first), while SEU6, SEU9, and SEU15 ranked third in terms of light utilization in the photosynthesis process. Moreover, variety Bhadra and accession SEU15 exhibited the highest chlorophyll content (in SPAD units), while SEU14 and Pacific ranked third and fourth, respectively.

Table 1. Mean responses of Leaf Area Index (LAI) and days taken to 50% flowering of tested maize landraces with the corresponding ranks (R1 and R2) of each trait.

Treatment	LAI	R1	$D_{50\%}$ (days)	R2
SEU2	2.0	3	44.25	1
SEU6	1.8	11	48.50	8
SEU9	1.8	11	48.00	7
SEU10	1.9	8	50.50	9
SEU14	1.7	14	53.50	10
SEU15	1.7	14	46.75	4
SEU16	1.8	11	46.75	4
SEU17	2.2	1	54.00	11
SEU18	1.9	8	54.00	11
SEU19	2.0	3	60.00	16
SEU20	1.9	8	58.67	14
SEU21	1.4	16	47.00	6
SEU22	2.0	3	59.00	15
SEU23	2.0	3	57.33	13
Pacific-999	2.2	1	45.75	2
Bhadra	2.0	3	45.75	2

LAI- leaf area index measured at 6 WAP, $D_{50\%}$ (in days) - varied according to germplasm inherent character. ±SEM for individual data points were excluded for the purpose of performing the RSI analysis.

Table 2. Mean responses of leaf chlorophyll fluorescence characteristics and chlorophyll content of tested maize landraces with the corresponding ranks (R3, R4 and R5) for each trait

Treatment	Qy_{light}	R3	Qy_{Dark}	R4	SPAD	R5
SEU2	0.63	6	0.73	1	51.9	8
SEU6	0.62	7	0.72	3	51.6	10
SEU9	0.62	7	0.72	3	51.8	9
SEU10	0.59	15	0.70	8	52.0	6
SEU14	0.59	15	0.70	8	52.4	3
SEU15	0.62	7	0.72	3	54.4	1
SEU16	0.60	14	0.71	6	52.0	6
SEU17	0.62	7	0.69	12	52.2	5
SEU18	0.65	2	0.70	8	47.5	13
SEU19	0.62	7	0.71	6	45.1	14
SEU20	0.64	4	0.69	12	42.0	16
SEU21	0.67	1	0.68	15	43.6	15
SEU22	0.64	4	0.68	15	48.0	12
SEU23	0.65	2	0.69	12	50.0	11
Pacific-999	0.62	7	0.73	1	52.3	4
Bhadra	0.61	13	0.70	8	54.3	1

Qy_{light} and Qy_{dark} depicts the maximum quantum yield of maize leaves taken at 6 weeks after field planting (WAP). The chlorophyll content was measured in SPAD units. R3, R4 and R5 represent the ranks given for Qy_{light} and Qy_{dark} and chlorophyll content of leaves. ±SEM for individual data points were excluded for the purpose of performing RSI analysis.

Similarly, the selection criteria favored the maize germplasms with the highest scores for A_N (photosynthetic rates) and WUE. The accessions with the best performance received the lowest rank numbers (Table 3). Pacific-999 showed the highest photosynthetic rates (ranked first), followed by SEU17, SEU16, and SEU9. Variety Bhadra was ranked eighth. Additionally, SEU6, SEU14, and SEU15 had the lowest stomatal conductance (gs), while the control varieties (Bhadra and Pacific-999) had comparatively higher stomatal conductance. In terms of leaf transpiration rates (E), SEU6 (ranked first), SEU14 (ranked second), and SEU15 (ranked third) exhibited the lowest rates, while Pacific-999 and Bhadra (ranked eighth and twelfth, respectively) had a comparatively higher water loss. Maize plants generally prefer improved water use efficiency, and SEU10, SEU9, and SEU16 ranked highest in this regard. Pacific-999 (ranked fifth) and Bhadra (ranked 10th) had comparatively lower WUE among the investigated plants.

Ranking of biomass and grain yield traits of maize

The results of the evaluation revealed noticeable variations in biomass and yield indices among the maize accessions. The maize accessions with the best performance were assigned the lowest rank numbers as they were preferred in the selection criteria due to their superior above-ground biomass (AGDM), grain quantity, and kernel weight (Table 4). SEU2 (ranked first), SEU16 (ranked second), and SEU9 (ranked 3third) produced the highest AGDM, while Pacific-999 and Bhadra ranked eighth and nineth, respectively. Additionally, SEU2, Pacific-999, SEU16, and SEU14 exhibited increased cob weight. On the other hand, Pacific-999 (ranked first), SEU2 (ranked second), and Bhadra (ranked third) had superior numbers of kernels per individual cob. SEU2, SEU15, and Pacific-999 had longer cobs compared to Bhadra, which was ranked fifteenth.

Overall rank summation index (RSI) and selection Index (SI) of maize germplasms

The RSI was calculated by summing up the rankings (R1 through R16) for each unique attribute. The results showed that SEU2, Pacific-999, SEU16, SEU15, and SEU9 had the lowest selection index (SI) values (1, 2, 3, 4, and 5, respectively), as well as the lowest RSI values of 70, 82, 96, 97, and 98, respectively (Table 5).

It is worth noting that the elite commercial maize varieties Pacific-999 (RSI of 82) and Bhadra (RSI of 124) appeared to be surpassed by the characteristics of accession SEU2 (RSI of 70). Furthermore, the local maize accessions SEU15, SEU16, SEU9, SEU10, and SEU17 exhibited superiority over the control variety Bhadra. However, certain accessions (particularly SEU20, SEU21, and SEU22) had characteristics that were not as favorable as those of the control plant.

Plant breeders strive for a straightforward and precise index to facilitate quick decision-making. The effectiveness of available indices needs to be evaluated to select the best and most straightforward index that would yield the predicted benefits in plant breeding (Oloyede-Kamiyo, 2019). It is crucial to determine the focal points of the breeding program and the plant selection criteria that promote desired changes (Reis *et al.*, 2004). Therefore, we propose a mathematically sound method suggested by Mulamba and Mock (1978) that appears to be effective for selecting Sri Lankan maize landraces. This method can be utilized in future breeding programs to increase maize grain production and reduce food insecurity in the country.

When selecting superior genotypes for crop breeding programs, plant breeders need to consider various aspects. When improvement is desired in only one plant attribute, associated characters are used to enhance the effectiveness of the selection process. However, finding genotypes with favorable scores multiple traits when selecting for complex qualities can be challenging. Hence, simplifying the selection method becomes necessary. The contemporary selection index approach allows the integration of the benefits of multiple agronomically significant traits (Vilarinho et al., 2003). Thus, the selection index approach facilitates the objective selection of subunits. Constructing an index of integrated traits proves to be more efficient than selecting based on a single trait or a few plant qualities (Ghaed-Rahimi et al., 2017).

Table 3. Mean responses of intrinsic leaf photosynthetic characteristics of tested maize landraces with the corresponding ranks given (R6, R7, R8, R9 and R10) for each trait

Treatment	A_N	R6	C_i	R7	g_s	R8	*E*	R9	*WUE*	R10
SEU2	25.50	6	97.52	6	0.23	8	3.42	5	7.58	7
SEU6	19.23	16	67.05	16	0.13	1	2.45	1	7.89	4
SEU9	27.12	4	117.53	1	0.26	10	3.44	6	8.06	2
SEU10	24.41	9	82.16	9	0.18	4	3.08	4	8.13	1
SEU14	19.76	15	85.45	8	0.15	2	2.76	2	7.26	9
SEU15	20.42	13	81.58	10	0.15	2	2.81	3	7.38	8
SEU16	28.16	3	103.89	4	0.28	13	3.73	10	8.00	3
SEU17	29.74	2	106.19	3	0.33	16	3.98	13	7.59	6
SEU18	24.98	7	71.90	14	0.26	10	4.47	15	5.74	15
SEU19	22.54	11	73.64	13	0.22	7	3.88	11	5.98	13
SEU20	25.82	5	67.08	15	0.27	12	4.52	16	6.12	12
SEU21	20.19	14	98.33	5	0.20	5	3.46	7	5.98	13
SEU22	21.72	12	74.85	12	0.20	5	3.68	9	6.39	11
SEU23	23.73	10	77.28	11	0.24	9	4.24	14	5.69	16
cv. Pacific-999	30.45	1	97.32	7	0.29	15	3.95	12	7.79	5
cv. Bhadra	24.50	8	111.42	2	0.28	13	3.62	8	7.19	10

A_N, Ci, gs, E and WUE depict the Net CO_2 assimilation rates (µmol CO_2 m^{-2} s^{-1}), intercellular CO_2 levels (µmol CO_2 m^{-2} s^{-1}), stomatal conductance (mmol H_2O m^{-2} s^{-1}), transpiration rates (mmol H_2O m^{-2} s^{-1}) and water use efficiencies (µmol CO_2 mmol H_2O^{-1}) of maize leaves taken at 6 WAP. The R6, R7, R8, R9 and R10 represent the ranks given for the corresponding leaf physiological traits. ±SEM for individual data points were excluded for the purpose of performing RSI analysis.

Table 4. Mean responses of biomass and grain yield characteristics of tested maize landraces with the corresponding ranks (R11, R12, R13, R14, R15 and R16) of each trait

Treatment	AGDM	R11	CW	R12	KW_{100}	R13	NC_{plant}	R14	NK_{cob}	R15	CL	R16
SEU2	459	1	232	1	32	5	1.3	9	501	2	25	1
SEU6	325	10	124	12	26	15	1.3	8	402	7	20	4
SEU9	412	3	141	8	31	7	1.4	6	402	6	19	8
SEU10	398	4	131	10	28	10	1.5	3	389	8	20	5
SEU14	390	6	167	4	27	12	1.6	2	356	10	19	6
SEU15	390	7	153	6	32	4	1.4	7	415	5	22	2
SEU16	438	2	196	3	32	6	1.6	1	420	4	19	7
SEU17	393	5	142	7	26	13	1.4	5	359	9	18	9
SEU18	254	11	128	11	39	2	1.0	11	328	11	17	10
SEU19	196	13	85	13	30	8	1.0	13	288	12	16	12
SEU20	160	15	76	14	28	10	1.0	12	241	14	15	14
SEU21	111	16	38	16	26	14	1.0	14	184	16	9	16
SEU22	188	14	60	15	34	3	0.9	16	185	15	15	15
SEU23	241	12	132	9	39	1	1.0	14	279	13	17	11
cv.Pacific-999	357	8	213	2	30	9	1.5	4	561	1	21	3
cv. Bhadra	352	9	158	5	24	16	1.2	10	465	3	15	13

AGDM, CW, KW_{100}, NC_{plant}, NK_{cob}, and, CL depict above-ground biomass (g $plant^{-1}$), cob weigh (g cob^{-1}), the number of developed cobs per plant, number of kernels per cob and individual cob length (cm), respectively. ±SEM for individual data points were excluded for the purpose of performing RSI analysis.

In comparison to the traditional selection methods among and within progenies, De Paiva *et al.* (2002) verified the efficacy of the RSI methodology proposed by Mulamba and Mock (1978) in selecting Barbados cherry progenies. Vasconcelos *et al.,* (2010) demonstrated that the Mulamba and Mock indices provided the most accurate estimates of genetic gain in superior alfalfa genotypes for productive, morphological, and chemical attributes. Cruz *et al.,* (1993) and Costa *et al.,* (2004) reported successful outcomes using the Mulamba and Mock indices in experiments involving corn and soybean.

Table 5. Rank summation index (RSI) of overall plant characteristics gathered from table 1, 2, 3, and 4 with the concurrent selection index (SI) of tested maize landraces.

Treatment	RSI	SI
SEU2	71	1
cv. Pacific-999	83	2
SEU16	100	3
SEU15	101	4
SEU9	103	5
SEU10	117	6
SEU17	128	7
SEU14	129	8
SEU6	136	9
cv. Bhadra	141	10
SEU18	161	11
SEU23	168	12
SEU19	176	13
SEU22	180	14
SEU21	189	15
SEU20	195	16

RSI was calculated by summing up of ranking of individual plant characteristics mentioned as R1+R2+R3+R4+R5+R6+R7+R8+r9+R10+R11+R12+R13+R14+ R15+R16. The lowest RSI obtained maize genotype was received the lowest SI value.

Our results indicate that the local landrace/accession SEU2 outperformed the commercial elite hybrid cv. Pacific-999 in terms of several photosynthetic and biomass properties. This suggests that local maize accessions have greater potential for developing novel hybrids. Additionally, five evaluated accessions exhibited superior qualities compared to the local variety Bhadra. Utilizing these superior maize accessions identified in our study can contribute to increasing maize yield in Sri Lanka through plant breeding programs.

CONCLUSIONS

Maize, as the world's highest-yielding grain crop, plays a crucial role in addressing food insecurity challenges in developing countries with rapidly growing populations. The results of our research indicate that maize landraces such as SEU2, SEU15, SEU16, SEU9, and SEU10 outperformed the cv. Bhadra in terms of photosynthetic activities, biomass, and grain yield production. However, the hybrid variety cv. Pacific-999 showed superior performance in photosynthetic and cob traits compared to the traditional landraces, except for SEU2. Further comprehensive field studies and laboratory evaluations are necessary to investigate the underlying factors responsible for the exceptional photosynthesis and biomass traits observed in SEU2 and to harness their potential for crop improvement programs. Additionally, these elite maize landraces identified can be recommended for future breeding programs aimed at developing new maize varieties at the national level.

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