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Evaluating the Growth and Yield Performances of Selected Rice (*Oryza sativa* L.) Varieties Grown in Organic Fertilizer

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Abstract

Organic rice cultivation has been receiving a lot of attention in Sri Lanka. Hence, this evaluated the growth and yield performances of 20 rice varieties including four traditional and 16 improved varieties under organic fertilization. The results indicated the significant differences for most of the tested parameters including plant height, flag leaf length and width, root length, tillers and panicle characters and dry weights between rice varieties. The traditional rice variety Madathawalu performed well in terms of plant height, panicle and above ground biomass traits compared to the improved varieties. The highest flag leaf length (42.6cm) was recorded in Madathawalu and the number of leaves per plant was in Bg360 (33.44) followed by Pokkari (28.55). However, tillering characteristics were superior in improved varieties (Bg360, Ld365 and Bg357). The highest root length was obtained in Sulai (15.87cm), while the lowest was in Bg372 (9.53cm). Bg369 had the highest 100 grain weight (3.29g) followed by Pokkari (2.95g), Suduheenaty (2.95g) and Bg 94-1 (2.9g), while the lowest was recorded in Ld365 (1.58g). Overall, the highest total panicle dry weight was observed in Madathawalu (24.29g) followed by Aeron 9-3 (22.7g) and Bg360 (20.16g) suggesting that these three rice varieties can be cultivated with the application of organic fertilizer.

Key words: *Compost, Dry matter, Flag leaf, Improved rice, Panicle, Traditional rice*

Introduction

Rice (*Oryza sativa* L.) is a highly consumed staple food all over the world as one of the primary sources of nutrition. The major rice producing countries are China, India, Indonesia and Thailand (Hussain *et al*., 2014). In Sri Lanka, rice occupies 34 % of the total cultivated area (DOA, 2020) and meets 42 % of an average person's daily protein requirement and 34 % of their daily calorie requirement (Department of Census and Statistics, 2020). The rice demand of the country is projected to be increased by 1.1 % annually and to fulfill this, a growth rate of 2.9 % per annum is needed in rice production (Thomas *et al*., 2018). Ampara district is one of major paddy cultivating districts in Sri Lanka along with Polonnaruwa, Kurunagala, Anuradapura and Batticaloa. The recent statistics states that 1,116,933 ha of land were used for paddy cultivation all over the country and in Ampara district around 136,036 ha of paddy was grown mainly with the At-362 and Bg-94/1 (DOA, 2020).

Various methods have been proposed for increasing rice production such as developing novel high yielding rice varieties, optimizing the usage of agro-chemicals (Singh *et al*., 2017; Rodnuch *et al*., 2019) converting C3

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photosynthetic cycles into efficient C4 mechanism through numerous means (Nagoor, 2013), and transgenic rice (Dutta *et al*., 2016). Generally, inorganic chemical fertilizers are used as the main source of nutrient supplement for higher yield. However, excessively large doses have caused soil-related issues including acidification, organic matter losses, structural deterioration (Chen, 2006; Zhong and Cai, 2007), and ground water pollution, reduction of biodiversity and also causes problems related to human health (Krupnic *et al*., 2004). On the other hand, the use of organic fertilizer is proposed as an alternative as an effective solution to avoid such problems (Moe *et al*., 2019). Organic farming has gained popularity in recent years as people have become more conscious of environmental issues and food safety (Singh *et al.*, 2017). Especially in Sri Lanka, due to the government policies on banning the importation of inorganic fertilizers, farmers tend to change to organic farming avoiding the usage of agrochemicals.

According to the previous literatures, the rice production, their demand and farmer's income were proved to be increased more effectively within two to three years under organic fertilizer than chemical fertilizer (Timsina, 2018; Sugiyanto *et al*., 2006: Mendoza, 2004). Increased yield attributes and growth of different rice varieties had been proved under organic fertilizer compared to chemical fertilizers (Singh *et al*., 2017; Santis *et al*., 2022). The response of rice to organic fertilizers related with growth and yield parameters is considered to be depended on plant species and genotypes (Ardiantika *et al*., 2018; Rodnuch *et al*., 2019). New, high-yielding rice varieties are particularly responsive to fertilizer applications and have a high nutrient demand. However, these types also deplete the soil nutrients more quickly than conventional varieties (Bijay-Singh and Singh, 2017). Despite the reduced production, traditional rice types are more in demand on the local and international markets due to their superior grain attributes, such as high fiber content (Wickramasinghe and Noda 2008). Therefore, this study was conducted to evaluate the growth and yield performances of selected traditional and newly improved rice varieties under organic fertilization.

Materials and Methods

Study area

The experiment was carried out at Rice Research Station, Sammanthurai in Ampara district (7° 22′N 81° 48′E; altitude 23 m above sea level) situated at the low country dry zone (DL_{2b}) agro-ecological region of Sri Lanka from May 2022 to September 2022 during the *Yala* season. . This study area receives an average rainfall of less than 1,750 mm of per annum and the average annual temperature is 27 °C. The major soil type in this area is Non-calcic Brown soil.

Planting material

A field trial was established with 20 selected rice varieties [fourteen improved varieties, two advanced breeding lines (Aeron-9-3 and Bg-11-802) and another four-traditional varieties] as indicated in Table 1. The rice varieties were already available in Rice Research Station, Sammanthurai.

Table 1: Selected rice varieties used in this field study.

Improved rice varieties	**Traditional rice varieties**
BG352, BW372, BG369, BW367, BG366, BW364, LD365, BG360, BG359, BG358, BG357, BG314, BG300, Aeron-9-3 (breeding line), BG11-802 (breeding line) and BG94/1 (Control)	*Suduheenaty, Sulai, Madathawalu* and *Pokkari*

Agronomic practices

Initially, nursery beds (1.5 m x 1.5 m) were prepared and 250 g of seeds in each variety were broadcasted in the nursery. After three weeks of sowing, rice seedlings were transplanted in the field with a spacing of 20 cm x 20 cm. The experiment was arranged in Randomized Complete Block Design (RCBD) with three replicates and the plot size was 5 m x 1 m. Irrigation was done in once in two days. Weeds were removed manually after three weeks of transplanting (WAT).

The compost (5 t/ha) (Turmuktini *et al.*, 2012) was used as organic fertilizer in this study. Well-decomposed cow dung, gliricidia leaves and japan gerbera were used to prepare the compost in 1: 1: 1 ratio which was applied to the field as basal dressing (3 t/ha) two weeks before transplanting. The top dressing (2 t/ha) was then done using compost after six WAT. The chemical characteristics of the soil from study area and compost used in this research are given in Table 2.

Table 2: Chemical characteristics of soil and compost

Characteristics	**Soil (Before rice establishment)**	**Compost**
pH	6.64	6.8
Electrical conductivity (mS/m)	2.3	9.8
N content	0.03 %	0.17 %
C content	2 %	16 %

Data collection

The data were collected from randomly chosen three plants in the middle row of each replicate. Plant height (cm) from the base of culm to the flag leaf, total number of leaves and also flag leaf length (cm) and width (cm) were recorded at flowering stage. Root length (cm) was measured from the base of the root to the end of the root tip of longest root as described by Himasha *et al*. (2022). At harvest, numbers of total tillers, productive tillers with panicle and unproductive tillers were counted. Then the panicle length was measured from the base of collar to tip of panicle as stated by Sivaneson and Vijayakumari (2019). Similarly, number of panicles, filled and unfilled grains per panicle, total panicle weight (g), stem dry weight, 100 grain weight and above ground biomass per plant (g) were recorded (Begum *et al*., 2018; Mubarak *et al*., 2022). Rice samples such as leaves, grains, panicles and stems were oven dried at 80 ^{o}C for 72 hours to obtain the dry weights.

Data analysis

The Statistical Package for Social Sciences (SPSS) was used to perform the data, and the analysis of variance (ANOVA) was utilized to compare the treatments statistically. The Tukey's test was used to determine the significant difference between treatment means at the 0.05 probability level.

Results and Discussion

In past, traditional rice varieties were cultivated by farmers, because of their adaptability to Sri Lankan environmental conditions and they are mostly associated with traditional farming systems. The traditional rice varieties are frequently genetically diverse, have a distinct identity, and no formal crop improvements (Villa *et al*., 2005). However, the relative significance and relevance of yield-related features have varied through time due to rice improvement programs. Only a few types of improved rice are currently cultivated to a great extent. The majority of them are recently developed, agrochemicals-dependent rice varieties including Bg (Bathalagoda), At (Ambalanthota) and Bw (Bombuwala). Several traditional rice types, such as *Kaluheeneti*, *Pachchaperumal, Madathawalu, Suwandel*, and Kuruwee, are grown on a small amount of land (Jayasumana *et al*., 2015).

Plant height of rice varieties at flowering stage

The different rice varieties showed significant variations in plant height at flowering stage ($p<0.05$). *Madathawalu* (120.3 cm) and *Pokkari* (119.7 cm) had produced tallest plants, while Bg357 had the lowest (80.3 cm) (Figure 1).

These results are in line with Suriyagoda *et al*., (2011) who stated that traditional rice varieties generally produce the tallest plant (> 100 cm) compared to the newly improved varieties under inorganic fertilizer applications. Based on the present study, similar results have been observed under organic fertilizer applications. Hasanuzzaman *et al*. (2010) obtained the plant height ranging from 74.6 cm to 106.5 cm for rice plants in wetland field conditions. Plant height is a crucial characteristic that affects the plant status and capacity for yield (Yan *et al.*, 1998).

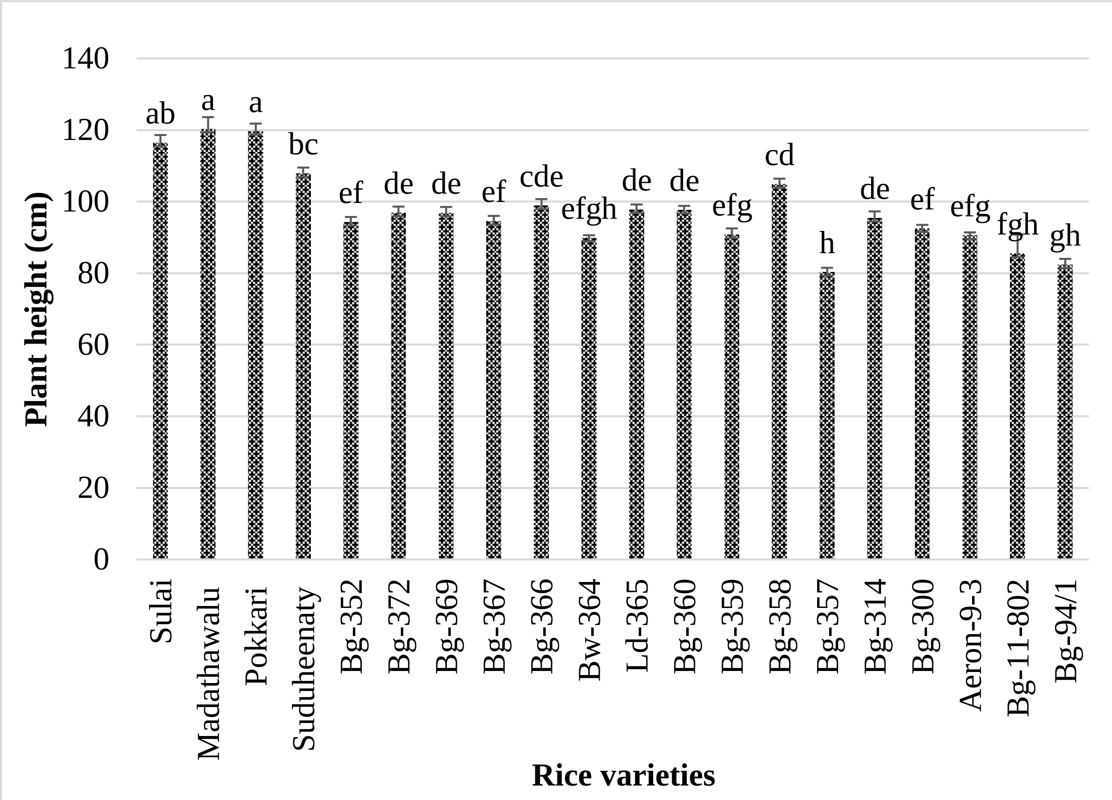

Figure 1: Impact of organic fertilizer on rice plant height (cm) at booting and flowering stage. Bars with different letters significantly different at p=0.05.

Leaf characteristics of rice varieties

The experimented rice varieties showed significant variations in leaf characteristics such as flag leaf length, width and number of leaves at their flowering stage under organic fertilizer application ($p<0.001$). *Madathwalu* had the highest flag leaf length (42.6 cm), whilst Bg-94-1 had the lowest (25.6 cm). The highest flag leaf width was recorded in Bg 359 (1.92 cm) while the lowest flag leaf width was in *Pokkari* and *Suduheenety* (0.76 cm). According to Siavoshi, (2011), the highest flag leaf length recorded in plants treated with 2.0 t/ha organic fertilizer was 29.48 cm. Higher number of leaves per plant was observed in Bg360 (33.4) followed by *Pokkari* (28.5), while the lowest number was in Bg372 (18.3) (Table 3). The number of leaves a rice plant produces can be used to estimate its growth stage. Moreover, the present study compared rice population containing a variety of cultivars with various days taken to maturity and harvest. A short-duration cultivar often produces fewer leaves from the main culm from germination to heading than a long-duration variety (Maniruzzaman *et al*., 2017). However, Amarasinghe *et al*. (2014) believe that cultivars with more leaves per plant are better suited to provide bigger yields. The canopy architectural features such upright, flat or droopy leaves of rice canopy contributes to the light interception, photosynthesis rates and final grain yield (Mubarak *et al*., 2022).

Table 3: The leaf characteristics of 20 rice varieties at flowering stage.

Treatments	Flag leaf length (cm)	Flag leaf width (cm)	Number of leaves per plant
Sulai	41.3 ± 2.3^{ab}	1.0 ± 0.03^{ab}	26.1±1.9^{abc}
Madathawalu	42.6 ± 2.7^{a}	0.9 ± 0.02^{ab}	20.0±1.4^{bc}
Pokkari	38.8 ± 1.3^{abc}	0.8 ± 0.01^{b}	28.6±1.7^{ab}
Suduheenaty	36.0 ± 1.8^{abcde}	0.8 ± 0.01^{b}	21.6±1.0^{bc}
Bg-352	29.5 ± 1.2^{efgh}	1.2 ± 0.04^{ab}	23.6±2.4^{abc}
Bg-372	32.6 ± 1.9^{cdefgh}	1.1 ± 0.03^{ab}	18.3±0.8^{c}
Bg-369	29.9 ± 1.6^{efgh}	1.0 ± 0.02^{ab}	27.0±2.7^{abc}
Bg-367	33.6 ± 1.3^{cdefg}	1.2 ± 0.03^{ab}	26.7±1.8^{abc}
Bg-366	34.2 ± 1.1^{bcdef}	1.3 ± 0.04^{ab}	27.2±2.4^{abc}
Bw-364	27.3 ± 0.7^{fgh}	0.9 ± 0.01^{ab}	21.6±1.2^{bc}
Ld-365	34.1 ± 1.7^{bcdef}	1.1 ± 0.02^{ab}	26.2±2.3^{abc}
Bg-360	37.9 ± 1.2^{abcd}	1.0 ± 0.02^{ab}	33.4±2.4^{a}
Bg-359	32.3 ± 1.3^{cdefgh}	1.9 ± 0.88^{a}	23.0±1.9^{bc}
Bg-358	33.6 ± 1.6^{cdef}	1.0 ± 0.02^{ab}	25.7±2.9^{abc}
Bg-357	31.0 ± 1.1^{defgh}	1.0 ± 0.03^{ab}	26.2±1.1^{abc}
Bg-314	28.8 ± 0.6^{efgh}	0.9 ± 0.03^{b}	20.1±1.4^{bc}
Bg-300	26.3 ± 0.3^{gh}	1.1 ± 0.01^{ab}	20.8±1.8^{bc}
Aeron-9-3	29.3 ± 0.8^{efgh}	1.0 ± 0.03^{ab}	19.7±1.3^{bc}
Bg-11-802	31.9 ± 0.7^{cdefgh}	1.3 ± 0.04^{ab}	22.8±2.4^{bc}
Bg-94-1	25.6 ± 1.0^{h}	0.9 ± 0.03^{ab}	23.4±2.6^{abc}
P value	0.001	0.001	0.001
Grand mean	32.8	1.06	24.09
CV %	18.7	57.54	27.72

CV: Coefficient of Variance. The values are means of three replicates ± standard error (SE); within a column. Means followed by the different letters are significantly different at p=0.05.

Tiller production in rice plant

The number of productive tillers and non-productive tillers per plant showed significant variations at harvesting stage ($p<0.0001$) (Table 4). Bg360 (7.9) had the highest number of total tillers per while the lowest was recorded in Bg372 (3.9). The highest number of productive tillers was noted in Bg360 (7.3), followed by Bg357 (5.7) while the lowest values (3.9) were seen in Bg372, Bg314 and Aeron. On the contrary, Bg367 (1.33) had the highest number of non-productive tillers per plant. The lowest number of non-productive tillers per plant was observed in Bg372. Tillering helps in improving rice yield whereas, productive tillering determines the eventual grain production (Kakade *et al.*, 2017).

The number of tillers produced by traditional rice varieties ranged 4.5-5.4 tillers per plant in this experiment.

However, the improved varieties ranged from 3.9 – 7.9 tillers per plant when plants grown under inorganic fertilizer treatment regimes (Suriyagoda *et al*., 2011). In a previous study, Himasha *et al*. (2022) reports that Aeron 10-26 produced increased number of tillers (9.5 tillers) with the provision of inorganic fertilizers.

Furthermore, this study showed that the Bg360 had a unique feature in producing large number of total tillers as well as the productive tillers with the panicles. Furthermore, Amarasinghe *et al*. (2014) reported that the Sri Lankan traditional rice cultivars during vegetative growth under recommended fertilizer application produce an average number of 1.55 to 7.3 tillers per plant.

Table 4: Tillering performances of 20 rice varieties under organic fertilizer

S/N	Treatments	Number of total tillers/plant	Number of productive tillers per plant	Number of non-productive tillers per plant
1	*Sulai*	5.4±0.3^{bc}	4.6±0.3^{b}	0.9±0.2^{ab}
2	*Madathawalu*	4.7±0.4^{bc}	4.3±0.3^{b}	0.3±0.2^{ab}
3	*Pokkari*	4.8±0.3^{bc}	4.1±10.2^{b}	0.7±0.3^{ab}
4	*Suduheenaty*	5.0±0.2^{bc}	4.7±0.3^{b}	0.3±0.2^{ab}
5	Bg-352	4.9±0.5^{bc}	4.8±0.5^{b}	0.1±0.1^{b}
6	Bg-372	3.9±0.3^{c}	3.9±0.3^{b}	0.0±0.0^{b}
7	Bg-369	5.7±0.6^{bc}	5.0±0.6^{b}	0.7±0.2^{ab}
8	Bg-367	6.0±0.3^{ab}	4.7±0.3^{b}	1.3±0.2^{a}
9	Bg-366	5.4±0.4^{bc}	4.6±0.5^{b}	0.9±0.2^{ab}
10	Bw-364	5.1±0.3^{bc}	4.3±0.2^{b}	0.8±0.2^{ab}
11	Ld-365	6.2±0.5^{ab}	5.4±0.6^{ab}	0.8±0.3^{ab}
12	Bg-360	7.9±0.4^{a}	7.3±0.4^{a}	0.6±0.2^{ab}
13	Bg-359	4.9±0.4^{bc}	4.1±0.3^{b}	0.8±0.2^{ab}
14	Bg-358	5.3±0.5^{bc}	4.6±0.5^{b}	0.8±0.1^{ab}
15	Bg-357	6.2±0.2^{ab}	5.7±0.2^{ab}	0.55±0.2^{ab}
16	Bg-314	4.8±0.3^{bc}	3.9±0.3^{b}	0.9±0.3^{ab}
17	Bg-300	4.9±0.3^{bc}	4.1±0.3^{b}	0.8±0.2^{ab}
18	Aeron-9-3	4.4±0.3^{bc}	3.9±0.3^{b}	0.6±0.2^{ab}
19	Bg-11-802	5.1±0.5^{bc}	4.3±0.4^{b}	0.8±0.3^{ab}
20	Bg-94/1	5.4±0.6^{bc}	4.9±0.5^{b}	0.6±0.2^{ab}
	P value	0.001	0.001	0.011
	Grand mean	5.3	4.65	0.65
	CV %	26.6	28.6	53.13

The values are means of three replicates ± standard error (SE); within a column. Means followed by the different letters are significantly different at p=0.05. C.V = Coefficient of Variance.

Root length of rice plant

In this study, significant differences were observed in root length of different rice varieties grown under organic fertilization. The highest root length was recorded in *Sulai* variety (15.87 cm) followed by Ld 365 (13.58 cm) and Bg314 (13.28 cm) while the lowest was recorded in Bg372 (9.53 cm) (Figure 2). Longer roots assist plants in drawing water and nutrients from the soil column's deeper layers (Wasson *et al.*, 2012). Understanding the root morphological traits is vital in producing new cultivar that can withstand moisture stress in fields (Himasha *et al.*, 2021).

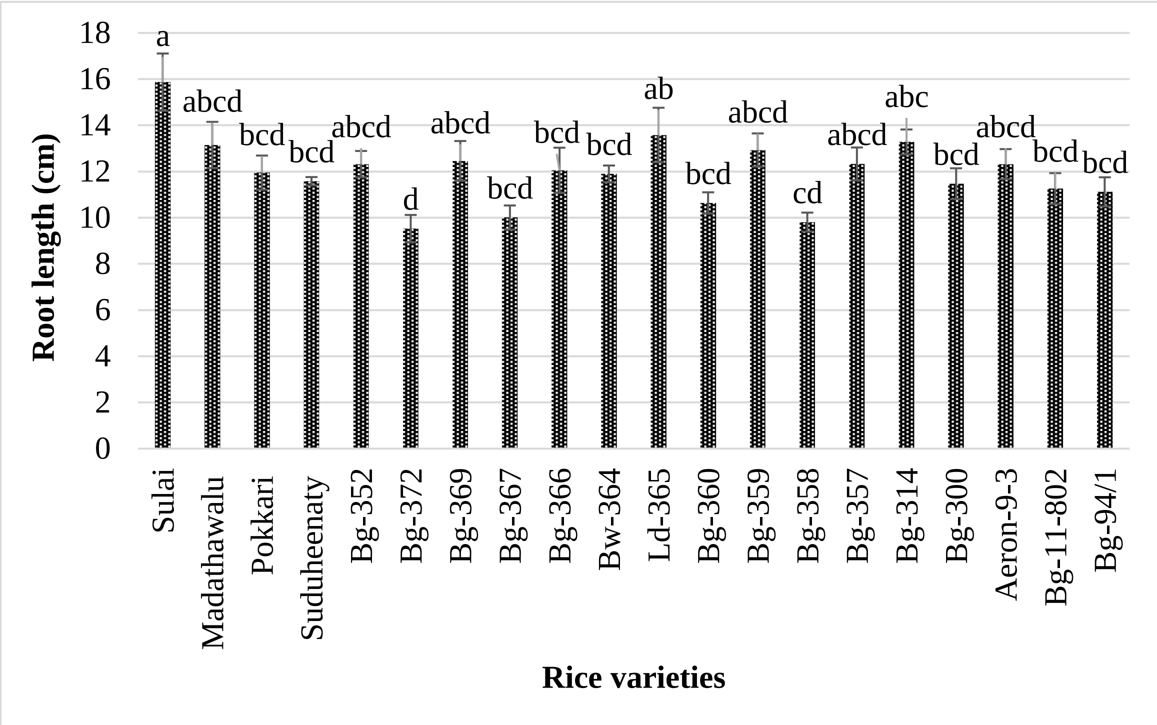

Figure 2: Root length of 20 rice varieties at flowering stage under organic fertilization. Bars with different letters are significantly different at p=0.05.

Yield characteristics of rice varieties

The recorded yield characteristics were significantly varied among the different rice varieties ($p<0.001$). Traditional rice varieties, *Suduheenaty* and *Madathawalu* had higher panicle length 23.9 cm to 23.4 cm respectively while Bg357 and Aeron9-3 had the lowest value (19.9 cm). The highest number of filled grains per panicle (155.3) was seen in Bg 358. Conversely, the control treatment (Bg94-/1) had the lowest (54.11). On the other hand, the highest number of unfilled grains per panicle was observed in Aeron 9-3 (104.3) while the lowest was observed in *Sulai* (25.4) and *Pokkari* (27.1). (Table 5). The highest stem dry weight per plant was obtained in Bg358 (12.12 gt) followed by *Sulai* (10.80 g) and *Suduheenaty* (10.68 g) while the lowest was in Bg11-802 (6.19 g) and Bw364 (5.99 g). In regard to total panicle dry weight produced per plant, all the rice varieties except *Sulai* had significantly higher panicle weight compared to the control. However, the highest value was observed in *Madathawalu* (24.29 g) followed by Aeron 9-3 (22.7 g).

Madathawalu also recorded the highest above ground biomass per plant (33.51 g), while the lower values were observed in Bg372 (20.38 g) (Table 5). Bg369 had the highest 100 grain weight (3.29 g) followed by *Pokkari* (2.95 gwhile the lowest was recorded in Ld365 (1.58 g) (Figure 3). In a previous study, Suriyagoda *et al*. (2011) recorded a range of filled grains in traditional rice varieties, from *Kaluheenati* (81) to *Dikwee* (166) per panicle grown under recommendedinorganic regime. They further observed the highest stem dry weight of 23 g perplant in *Godawee* followed by *Suwanda Samba* (22.6 g perplant) traditional rice while the lowest was in Bg305 (9.4 g perplant).

In this experiment, the *Madathawalu* traditional rice variety performed well in total weight of panicles per plant than the tested rice varieties. Among improved varieties and breeding lines, Aeron 9-3 and Bg360 responded well in grain weight. Most of the improved varieties produced substantial amount of grain yield. Plants have the ability to adjust their growth and yield performances according to the nutrient availability in the soil. Although organic fertilizers comprise lower nutrient compositions, the nutrients are released to crop root zones at a slower rate compared to the inorganic highly concentrated nutrients (Jemziya, and Mubarak, 2018). As such, the rice crops adjust growth and developmental processes, characterized by lesser numbers of producing tillers, root numbers and length, size and number of panicles, and the ratios varies with filled and unfilled spikelets, adjust the dry matter partitioning between shoots and the panicles in required ratios, and eventually produce lesser grain yield (Rodnuch *et al*., 2019. This was particularly true for the improved rice varieties as they respond highly to nutrient-rich fertilizer sources. Therefore, the crop yield was lesser in improved rice cultivars.

Table 5: Yield characteristics of 20 rice varieties used in this study

Treatments	**Length of panicle (cm)**	**No of filled grains per panicle**	**No of unfilled grains per panicle**	**Total panicle weight (yield) per plant (g)**	**Stem dry weight per plant (g)**	**Above ground biomass per plant (g)**
Sulai	22.5 ± 0.5^{abcd}	85.2 ± 4.7^{efghi}	25.4 ± 1^{f}	12.93 ± 0.71^{c}	10.80 ± 0.61^{ab}	23.74 ± 0.91^{abc}
Madathawalu	23.4 ± 0.3^{ab}	135.8 ± 9.5^{abc}	97.8 ± 0.6^{ab}	24.29 ± 3.01^{a}	9.20 ± 0.32^{bcde}	33.51 ± 2.87^{a}
Pokkari	23.2 ± 0.4^{ab}	111.9 ± 4.3^{cdef}	27.1 ± 2.27^{f}	16.92 ± 1.01^{abc}	9.74 ± 0.31^{bcd}	26.66 ± 1.02^{abc}

Suduheenaty	23.9 ± 0.2^{a}	68.9 ± 3.7^{ghi}	53.9 ± 8.7^{cdef}	18.77 ± 3.25^{abc}	10.68 ± 0.26^{abc}	29.45 ± 3.14^{abc}
Bg-352	21.4 ± 0.3^{bcde}	71.8 ± 5.1^{ghi}	53.9 ± 5.3^{cdef}	13.55 ± 1.43b^{bc}	7.50 ± 0.37^{efg}	21.05 ± 1.61^{bc}
Bg-372	20.4 ± 0.6^{de}	123.1 ± 6.9^{abcd}	35.4 ± 3.2^{ef}	13.47 ± 1.53^{bc}	6.90 ± 0.41^{fg}	20.38 ± 1.47^{c}
Bg-369	21.6 ± 0.3^{abcde}	72.8 ± 5.8^{ghi}	33.2 ± 2.9^{f}	17.85 ± 2.66^{bc}	7.10 ± 0.47^{fg}	24.95 ± 2.49^{abc}
Bg-367	20.8 ± 0.4^{cde}	144.0 ± 6.4^{abc}	52.2 ± 6.6^{cdef}	17.34 ± 1.68a^{bc}	7.65 ± 0.36^{efg}	24.99 ± 1.55^{abc}
Bg-366	23.2 ± 0.6^{ab}	79.2 ± 4.6^{fghi}	53.3 ± 5.3^{cdef}	15.67 ± 1.7a^{bc}	8.79 ± 0.30^{bcdef}	24.47 ± 1.64^{abc}
Bw-364	21.1 ± 0.4^{bcde}	66.8 ± 4.5^{ghi}	74.7 ± 6.1^{abc}	15.34 ± 1.29^{abc}	5.99 ± 0.26^{g}	21.34 ± 1.25^{abc}
Ld-365	20.4 ± 0.6^{de}	143.0 ± 6.4^{abc}	32.7 ± 3.7^{f}	15.27 ± 2.03^{abc}	8.68 ± 0.52^{cdef}	23.97 ± 2.07^{abc}
Bg-360	21.7 ± 0.5^{abcde}	112.2 ± 5.8^{cdef}	42.3 ± 6.5^{def}	20.16 ± 1.33^{abc}	7.26 ± 0.39^{efg}	27.42 ± 1.45^{abc}
Bg-359	21.1 ± 0.3^{bcde}	118.0 ± 4.8^{bcde}	39.56 ± 4.1^{ef}	16.77 ± 2.61^{abc}	8.58 ± 0.55^{def}	25.35 ± 2.84^{abc}
Bg-358	22.4 ± 0.5^{abcd}	155.3 ± 13.1^{a}	45.9 ± 4.0^{cdef}	16.97 ± 2.43^{abc}	12.12 ± 0.48^{a}	29.09 ± 2.62^{abc}
Bg-357	19.9 ± 0.4^{e}	62.2 ± 5.3^{hi}	71.3 ± 14.8^{bcd}	17.05 ± 1.77^{abc}	8.35 ± 0.49^{def}	25.41 ± 1.58^{abc}
Bg-314	21.9 ± 0.5^{abcde}	88.8 ± 5.0^{efgh}	39.9 ± 2.8^{ef}	13.11 ± 1.2^{bc}	7.24 ± 0.33^{efg}	20.35 ± 1.37^{c}
Bg-300	23.0 ± 0.4^{abc}	130.6 ± 6.9^{abc}	64.4 ± 10.2^{cde}	19.57 ± 1.45^{abc}	8.93 ± 0.37^{bcdef}	28.50 ± 1.62^{abc}
Aeron-9-3	19.9 ± 0.7^{e}	97.0 ± 5.1^{defg}	104.3 ± 5.5^{a}	22.70 ± 1.44^{ab}	7.50 ± 0.32^{efg}	30.22 ± 1.52^{ab}
Bg-11-802	21.7 ± 0.4^{abcde}	150.2 ± 10.5^{ab}	46.4 ± 3.3^{cdef}	17.98 ± 1.51^{abc}	6.19 ± 0.20^{g}	24.17 ± 1.54^{abc}

Bg-94-1	21.7 ± 0.5^{abcde}	54.11 ± 3.18^{i}	36.8 ± 2.1^{ef}	12.98 ± 1.61^{c}	7.07 ± 0.32^{fg}	20.05 ± 1.49^{c}
P value	0.001	0.001	0.001	0.001	0.001	0.001
Grand mean	21.7	103.5	51.5	16.94	8.31	25.25
CV %	8.13	35.73	52.66	36.65	23.22	25.78

The values are means of three replicates ± standard error (SE); within a column. Means followed by the different letters are significantly different at *p*=0.05. C.V = Coefficient of Variance.

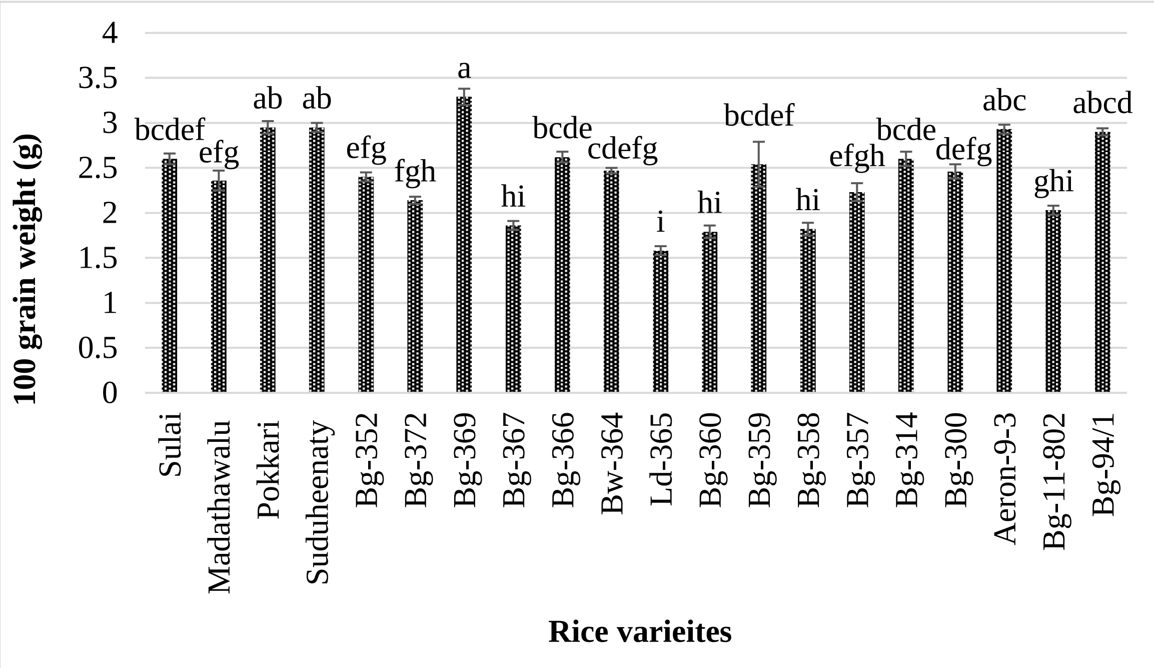

Figure 3: The 100 grain weight (g) of 20 rice varieties under organic fertilization. Bars with different letters are significantly different at p=0.05

Conclusions

The present study showed that different rice varieties can be grown under organic fertilizer application. According to our findings, the most of the traditional rice varieties to organic fertilizer improved growth and yield parameters compared with the improved varieties. Farmers can grow *Madathawalu*, *Pokkari*, and *Suduheenaty* traditional varieties under organic fertilizer applications. Similar grain yield can also be obtained with the Bg360 and Bg300. It is also further suggested to develop new rice varieties by using Aeron9-3 in rice breeding programs as this advanced breeding line performed better panicle yield among the improved rice varieties.

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