Evaluation of Agronomic and Yield Characteristics of Selected Rice Varieties Grown Under Organic Conditions

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Abstract

Organic rice farming has gained increasing attention throughout the world in recent past. Therefore, best rice varieties needed to be identified to perform well under organic conditions for increasing rice grain yield.This study was carried out at Regional Rice Research Center, Bombuwela to identify the best improved and traditional rice varieties for organic farming. Seven improved Bw361, Bw363, Bw364, Bw272-6b, Bg359, Bw03-1073, Bw05-1621 and two traditional rice varieties *Herath banda* and *Murungakayan* were cultivated under Randomized Complete Block Design with three replicates. A total of five (05) agronomic traits (Growth rate at seedling stage (GR),Culm Length (CL), Panicle length (PL), Days to 50% flowering (DF), Days to maturity (DM),and five (05) yield characteristics (Panicle weight (PW), Number of spikelets per panicle (NS), Number of filled spikelets per panicle (NFS),100 grain weight (SW), Net plot yield (GY) were measured from selected 10 plants per each plot. Analysis of variance performed on the selected traits revealed that improved varieties, Bw 361,Bw 363, Bw364 Bw359 and traditional variety *Murungakayan* were the best for organic farming. Among them Bw 361, Bg359, Bw 363 yielded above 4t/ha (over 80bu/ac) under organic condition in low country wet zone.

Key words: Rice, Yield, Characteristics, Organic

Introduction

Rice (*Oryza. sativa* L.) is an important world staple food and is consumed by nearly one-half of the global population (Fageria and Baligar, 2003). In Sri Lanka, rice occupies 34 percent (0.77 million ha) of the total cultivated area (Agstat 2008). Modern agricultural systems have been developed to obtain the highest yields and the highest economic profits. Intensive tillage, application of inorganic fertilizer, irrigation, chemical pest and disease control and genetic manipulation of crop plants are practiced to achieve these goals. Industrial countries use 72 million tons of chemical fertilizer while developing countries use 43 million tones (Census and Statistics 2009, Central Bank 2009). Rice cultivation in Sri Lanka during pre green revolution era used long duration indigenous varieties, had single season cultivation and used bone meal as a fertilizer. There were no herbicides and pesticides and no pressure to increase yield. But at present, the high yielding rice types that are used in 99% of the cultivation need chemical fertilizer. Annual estimated requirement of fertilizer is 0.32 million mt and this entire requirement is annually imported to Sri Lanka incurring a cost of 2.88 billion rupees (Sri Lanka Customs, Central Bank 2010). Applying chemical fertilizer in excess to the crop can contaminate the wells and nitrates in drinking water cause a health problem to the animals and people. The extensive use of pesticides creates more direct problems for farm workers (Weerakoon *et al.*, 2000).

Organic Farming, which is responsible for material recycling in agricultural ecosystem and crop production with minimal environmental load, has played a crucial role from ecological protection and agricultural production (Dahama 1997). The use of traditional varieties had major problems of lodging and less yield potential under organic conditions. Therefore, objective of this study was to identify best improved rice varieties and promising traditional rice varieties for organic rice farming.

Materials and Methods

The experiment was conducted at the Regional Rice Research and Development Center, Bombuwala. Seven improved (Bw361, Bw 363, Bw364, Bw272-6b, Bw 05-1621, Bw 03-1073, Bg 359) and two traditional (Murugakayan and Herathbanda) rice varieties were used as experimental materials.

For the field layout Randomized Complete Block Design (RCBD) was used with 3 replicates during *yala* season. For each replicate seeds of each variety was sown in 3m x 5m plot with 18 cm between hills and rows. Soil PH and EC was measured for each plot before seeds sowing and adding fertilizer amendments. At land preparation,each plot was treated with different organic materials on the given table below.

Experiment was maintained under rainfed condition. Weeds developed in the plots were hand-removed at 4th week and 6th week and plant thinning was done at 13th after seed sowing. Powdered neem seeds with rate of 500g/10 l of water soaked for 24 hours filtered and sprayed at 3 days interval for thrips at 2nd week and for paddy bug at flowering to maturity stage.

A total of five (05) agronomic and five (05) yield characteristics were measured at various growth stages using the standard evaluation system for rice developed by the International Rice Research Institute (IRRI) as indicated in Table3. Data were analyzed using ANOVA and The Duncan's Multiple Range Test (DMRT) was carried out to examine significant differences between factors.

Results and Discussion

Agronomic Characters

Analysis of variance performed on the selected traits revealed significant differences among the tested varieties. Growth rate increased from 6th week to 8th week in all varieties. Significantly highest growth rate

Table 1. Description of tested varieties

Variety	Characters
Bw 361	3½ months, red pericarp, moderately resistant to GM,BPH. recommended for dry and intermediate zone.
Bw 363	3 ½ months, white pericarp, moderately resistant to blast, GM,BPH and tolerance to iron toxicity.
Bw 364	3 ½ months, red pericarp, moderately resistant to blast, GM,BPH and tolerance to iron toxicity, recommended for wet zone
Bw 272-6b	3 months, red samba, resistant to blast, tolerance to logging, susceptible to iron toxicity, recommended for low country wet zone
Bg 359	3-3 ½ months, white pericarp samba, resistant to blast, GM,BPH, moderately resistant to iron toxicity, recommended for wet zone
Bw 05-1621	3 ½ months, red pericarp, tolerance to iron toxicity
Bw 03-1073	3 months, red samba
Herathbanda	3½ months, red pericarp,120-130 cm plant height, susceptible to logging, low tillering
Murungakayan	4-4 ½ months, white pericarp,127-135cm plant height

Table 2. Fertilizer combinations utilized at different growth stages

	Gliricidia t/ac	ERP Kg/ac	BRH Kg/ac	Rice Straw t/ac	Gliricidia Kg/plot	ERP g/plot	BRH g/plot	Rice Straw Kg/plot
Basal	2	100	250	2	7.5	375	937.5	7.5
2-3 wks	2				7.5			
5-6 wks	2				7.5			

(ERP-Eppawala Rock Phosphate,BRH-Burn Rice Husk)

Table 3. Selected Characteristics and their methods of measurements

Character	Method of measurement
Growth Rate-GR	GR at 6th week=(seedling height 6th week-seedling height 4th week)/Time
	GR at 8th week= (seedling height 8th week-seedling height 6th week)/Time
Culm Length (cm)-CL	Height from the ground level to base of the panicle after heading
Panicle length(cm)-PL	Length from the base to tip of the panicle
Days to 50% flowering-DF	Time duration from the date of sowing to 50% flowering
Days to maturity-DM	Time duration from seeding to the time more than 80% of the grains on the panicles are fully ripened.
Panicle weight-PW(g)	Average weight of 10 panicles at 14% moisture level
Number of spikelets per panicle-NS	Average number of spikelets from 10 panicles
Number of filled spikelets per panicle-NFS	Average number of filled spikelets from 10 panicles
1000 seed weight -SW(g)	Weight of 100 filled seeds/100)*1000
Grain Yield-GY(t/ha)	Net plot yield without border.Net plot size was 10.824m^2

observed for Herathbanda variety at both weeks while Bw 361 showed the lowest growth rate (2.64) at 6th week Bw 363 (6.86) was 8th week. Significantly highest culm length (91.87cm), panicle length (26.73cm) also observed in Herath banda variety while Bw 359 showed the lowest culm length (62.97cm) and Bw 363 showed the lowest panicle length (21.06cm).Significantly highest number of days to 50% flowering was observed for the Bw 05-1621 breeding line. Bw 03-1073 breeding line showed the lowest number of days. There were no significant variations for the number of days to maturity among all rice varieties except Bw

Table 4. Mean comparison of agronomic traits of selected rice cultivars

Treatment	Trait					
	GR 6th	GR 8th	CL	PL	DF	DM
Bw 05-1621	3.15^{de}	10.05^{bc}	76.9^{b}	24.83^{ab}	81.0^{a}	108^{a}
Bw 364	4.16^{cd}	9.45^{bcd}	77.47^{b}	23.23^{bc}	71.67^{de}	94.33^{b}
Bw 361	2.64^{e}	7.38^{cd}	54.03^{d}	21.17^{d}	76.33^{bc}	107.33^{a}
Bw 363	3.21^{de}	6.86^{d}	55.67^{d}	21.06^{d}	76.33^{bc}	107^{a}
Bw 359	3.16^{de}	8.39^{bcd}	62.97^{c}	21.53^{cd}	78.33^{ab}	106.33^{a}
Bw 272-6b	5.35^{b}	10.46^{b}	70.8^{b}	26.4^{a}	74.33^{cde}	95^{b}
Bw 03-1073	3.77^{cd}	10.40^{b}	73.37^{b}	25.1^{ab}	70.67^{e}	91.67^{b}
Herathbanda	8.77^{a}	13.27^{a}	91.87^{a}	26.73^{a}	75^{bcd}	105^{a}
Murungakayan	4.56^{bc}	9.24^{cd}	76.83^{b}	24.97^{ab}	74.33^{cde}	105.67^{a}
CV%	13.37	15.53	5.19	4.72	2.73	2.89

(GR-Growth Rate, CL-Culm Length, PL-Panicle Length, DF-Days to Flowering, DM-Days to Maturity)
(Different letters behind the mean value indicate significant differences between populations based on Duncan's Multiple Range Test).

272-6b and Bw 03-1073 breeding line. Growth rate at 8th week was the most variable (CV-15.53%) trait while Number of days to 50% flowering was the least variable (CV-2.73%) character.

Yield related characters

There were significant differences ($p<0.05$) in yield related traits among the tested rice varieties.

Bw 361 showed the highest panicle weight (2.99 g) while Bw 03-1073 breeding line showed the lowest value (1.96 g) for panicle weight. No significant difference was observed for the Number of spikelets per panicle among all varieties except Bw 03-1073 breeding line and Herath banda variety. Significantly the highest number of filled spikelets per panicle was observed for Bw 272-6b compared to that of Bw363, Bw 359 and Herath banda varieties. Herath banda showed the significantly the highest seed weight (3.15) than others. The highest ($P<0.05$) grain yield was observed for Bw 363 compared to that of Bw 03-1073 breeding line and Herath banda traditional variety. Among the yield related traits Panicle weight was the highest variable character (CV-18.03%) while 100 seed weight was the least variable (2.69%) character.

Table 5. Mean comparison of characters

Treatment	Trait				
	PW	NS	NFS	SW	GY
Bw 05-1621	2.43^{ab}	124.3^{ab}	97.73^{b}	2.25^{c}	3.17^{abc}
Bw 364	2.79^{ab}	136.07^{ab}	102.2^{ab}	2.53^{b}	3.64^{ab}
Bw 361	2.99^{a}	156.27^{a}	113.63^{ab}	2.46^{b}	4.08^{a}
Bw 363	2.7^{ab}	143.97^{ab}	95.83^{b}	2.51^{b}	4.21^{a}
Bw 359	2.51^{ab}	123.33^{ab}	94.37^{b}	2.53^{b}	4.01^{ab}
Bw 272-6b	2.48^{ab}	147.63^{ab}	134.43^{a}	1.74^{d}	3.89^{ab}
Bw 03-1073	1.96^{b}	115.4^{b}	102.63^{ab}	1.75^{d}	2.92^{bc}
Herathbanda	2.67^{ab}	113.17^{b}	78.57^{b}	3.15^{a}	2.41^{c}
Murungakayan	2.64^{ab}	126.87^{ab}	106.77^{ab}	2.24^{c}	3.89^{ab}
CV%	18.03	15.59	17.87	2.69	16.23

(PW-Panicle Weight,NS-No of Spikelets/Panicle,NFS-No of Filled Spikelets/Panicle,SW-Seed Weight,GY-Grain Yield)
The letters behind the mean value indicate significant ifferences between populations based on Duncan's Multiple Range Test. Mean with the same letters are not significantly different.

The traditional variety Herath banda showed the highest performances for the agronomic traits such as growth rate, culm length, panicle length and days to maturity. But it showed the lowest number of filled spikelets per panicle and the lowest grain yield at ripening stage. Therefore, improved rice varieties, Bw 361, Bw 364, Bw 363, Bg 359 and traditional variety Murungakayan are the best varieties for the organic farming. Among them Bw 361, Bg359, Bw 363 was yielded above 4t/ha (over 80 bu/ac) under organic condition in low country wet zone.

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