PERFORMANCE OF SIX NEW IMPROVED RICE (*Oryza sativa* L.) VARIETIES IN THE BATTICALOA DISTRICT

S. Srikrishnah, T. H. Seran
Department of Crop Science, Faculty of Agriculture,
Eastern University, Sri Lanka

ABSTRACT

A trial was conducted to evaluate the agronomic performances of six test varieties of rice viz. Bg 02. 465, Bg 03.1451, At 676, Bw 03.1063, At 307, and At 303 along with the check varieties of Bg 305, and Bg 300 of 3 months age group during *Yala* 2007 at the Agronomy farm of the Eastern University, Sri Lanka. The treatments were arranged in a Randomized Complete Block Design (RCBD) with four replications. The crop was raised and managed in accordance with the guidelines given for a National Co-ordinated Rice Varietal Trial (NCRVT) by Rice Research and Development Institute (RRDI), Sri Lanka. Germination percentage, number of tillers per plant, days to 50% heading, days to 85% maturity, lodging and the yield were recorded. Collected data were analyzed statistically to determine the treatment effects if any. Varieties tested in this trial showed significant differences in the selected agronomic characteristics.

The test variety 'Bw 03.1063' showed the high number of tillers (4.5) per plant. It was higher than the standard checks. Varieties 'At 676' and 'At 307' had taken significantly ($p<0.05$) less number of days (81 days) to reach 50% heading and varieties 'Bg 02.465' and 'At 676' had taken significantly ($p<0.05$) short duration (106 days) to reach 85% maturity. The test varieties did not lodge during the experiment and there were no significant differences observed in the germination percentage of the varieties. High yield (1,794 kg ha^{-1}) was obtained from the test variety 'Bw 03.1063' followed by 'At 676' (1697.5 kg ha^{-1}) and it was significantly higher than the check variety 'Bg 305' (1417 kg ha^{-1}). In the present study, it was found that test variety 'At 676'could be considered as suitable variety for the cultivation in the Batticaloa district during *Yala* season. Because, it produced higher number of tillers, matured early and produced higher yield than the check varieties. Though, further study is needed in *Maha* season and also under farmers' field to ensure its potentiality.

Key words: Test varieties, Check varieties, NCRVT, 50% heading, 85% maturity, Yield

INTRODUCTION

Rice (*Oryza sativa* L.) is the momentous world food crop. It's a staple food for more than 90% of the people in Sri Lanka. Rice occupies 34% of the total cultivated area in Sri Lanka and about 1.8 million farm families directly engaged in rice production (Dissanayake, 2000). Sri Lanka has ideal climatic condition and soil type for the rice cultivation in almost all the part of the country. In general, rice is cultivated in two main seasons namely *Yala* (irrigated) and *Maha* (rain-fed). New improved varieties released by the National Rice Research and Development Institute (RRDI) has the yield potential of 10 t/ha. However, yield per hectare fluctuates around 3.6 t/ha and Sri Lanka produces annually average of 2.6 million tons of rough rice. This contributes about 95% of the national rice requirement. It was projected that the demand for rice increases 1.1% per year. In order to meet this demand cropping intensity and national average yield should rise to 135% and 5 t/ha levels respectively (Anon., 2000). The low and stagnating yields of present varieties limit the scope of increasing production (Perera, 2000).

At present, demand and price of rice is escalating day by day. It is due to various reasons such as raise in the population, decrease in the extent of cultivation, hike in the price of wheat flour and increase in the cost of cultivation of paddy. Thus, current production of rice is not sufficient for the local consumption and rice is imported from other countries mainly from the India, which is one of the largest producers of rice. Rice import consumes part of our foreign exchange, which could be utilized for the development.

Sri Lanka has 24 agro-ecological zones and each of these differ significantly in amount of rainfall, temperature, elevation and soil types. Therefore development and identification of suitable adaptive rice varieties plays a vital role in terms of rice production. Selection of a suitable variety for a geographical location is an important task as high yielding varieties play a major role in uplifting the country's economy. Rice varietal improvement to various rice growing eco-system is a pre-requisite to increase rice production. The new improved rice varieties bred at RRDI are tested through National Co-ordinated Rice Varietal Trial (NCRVT) at various locations in the country before they are released to the farmers. Hence, this investigation was carried out to evaluate the performances of six improved rice test entries of 3 months age group in the Batticaloa district.

MATERIALS AND METHODS

Location

This experiment was carried out at the Agronomy farm of the Eastern University, Sri Lanka from June to September 2007. The Altitude of the site is around 100 m above mean sea level and it comes under the Agro-ecological zone of the Low Country Dry Zone (DL_2). The annual mean temperature varies from 28 °C to 32 °C and the humidity ranges from 50 % to 80 %. The annual rainfall of the district varies from 1800 mm to 2100 mm. The average temperature and the relative humidity were 32 ± 1.5 °C and 60 ± 1.4 % respectively during the experimental period.

Treatments and experimental design

There were eight treatments in this experiment and each treatment was replicated four times. The treatments were as follows:

1. T_1- Bg 02.465
2. T_2- Bg 03.1451
3. T_3- AT 676
4. T_4- Bw 03.1063
5. T_5- AT 307
6. T_6- Bg 305 (Check variety)
7. T_7- Bg 300 (Check variety)
8. T_8- At 303

These treatments were arranged in a Randomized Complete Block Design (RCBD). The net and gross plot sizes were 5.4 m × 2.4 m and 6.0 m × 3 m respectively.

Planting

Ploughing was done once followed by leveling to ensure weed control and a suitable seedbed. Bunds were made between plots as to separate each other. The seeds of rice varieties were obtained from the RRDI, Batalagoda. The crop was raised in accordance with the recommendations given for a National CRVT. The seeds were sown at the rate of 2 bushel per acre. Row seeding was practiced for crop establishment. Three seeds were dibbled in a planting hole. The depth of planting hole was 1.5 cm. Thinning out and gap filling were done at 15 days after the emergence of the seedlings. Two vigorous plants were allowed to grow in each hole. The plants were maintained at a spacing of 20 cm between the rows and 15 cm within a row.

Fertilizer application

Urea (5 kg ac^{-1}), Triple Super Phosphate (25 kg ac-^{1}) and Muriate of Potash (15 kg ac^{-1}) were applied as basal fertilizers before sowing. Top dressing was done with two doses of Urea at 4th and 6th weeks after planting at the rate of 35 kg ac^{-1} and 50 kg ac^{-1} respectively.

Plant protection measures

The economic pests found in the rice field were leaf folder, paddy bug and stem borer. Therefore, 40 ml of *Chloropyriphos* was mixed with 16 L of water and applied to control the leaf folders and stem borers, while 40 ml of *Elsan* was applied after mixing with 16 L of water to control the paddy bugs. Hand weeding was done continuously to maintain the field weed free especially before the fertilizer application.

Irrigation

Watering was done daily in the morning until germination and then irrigation was given continuously to keep soil at Field Capacity. Irrigation was evaded on rainy days.

Measurements

Following measurements were taken during the experimental period.

Germination percentage

Germination percentage of the seeds belongs to different entries was tested before seeding. Hundred seeds of each variety were placed between moisten filter paper in petri dish and covered. Number of germinated normal seedlings was counted at 6th and 10th days from two replications.Germination percentage was calculated using the following equation:

$$\text{Germination (\%)} = \tfrac{1}{2}(x/100 + y/100) \times 100$$

x- Number of normal seedlings at 6 days
y- Number of normal seedlings at 10 days

Number of tillers per plant

From each treatment, 20 plants were randomly selected at the flowering stage and the number of tillers per plant was counted manually.

Days to 50% heading and 85% maturity

Number of days required to reach 50% heading and 85% physiological maturity was counted for each treatment.

Lodging assessment

It was done during the dough and mature stages. Degree of lodging of test entries was estimated by visual observations using standard evaluation scale.

Table 1. Standard evaluation scale for lodging assessment

Grade	Degree of Lodging
1	No lodging
2	Most of the plants slightly lodged (More than 50%)
3	Most of the plants moderately lodged
4	Most of the plants nearly flat
5	All plants flats

Yield

Plots belonging to different treatments were harvested individually at maturity and grains were separated by threshing and seed dry weight of each plot was determined.

Statistical analysis

The collected data were statistically analyzed and the means were separated by DMRT technique.

RESULTS AND DISCUSSION

Agronomic characters

Selection of suitable variety for a locality requires an understanding of the agronomic characters that determine the yield. In the present study, significant ($p<0.05$) differences were observed in the selected agronomic characters such as number of tillers per plant, days to 50% heading and days to 85% maturity among the treatments (Table 1). However, no significant ($p<0.05$) differences were observed in the germination percentage and degree of lodging among the tested entries.

Table 2. Agronomic characteristics of test varieties and check varieties (3 months) of rice during *Yala* season

Variety	Germination (%)	Number of tillers/ plant*	50% heading (days)*	85% maturity (days)*	Lodging (dough stage)	Lodging (mature stage)
Bg 02-465	84	3.25 b	84.25 d	106.00 d	1	1
Bg 03-1451	88	3.5 ab	91.50 b	110.00 ab	1	1
At 676	89	4.25 ab	80.75 e	105.25 d	1	1
Bw 03-1063	86	4.50 a	85.00 d	107.50 c	1	1
At 307	88	3.75 ab	80.75 e	109.50 b	1	1
Bg 305 (check)	84	4.25 ab	93.00 a	111.00 a	1	1
Bg 300 (check)	90	4.25 ab	86.75 c	109.25 b	1	1
At 303	86	3.75 ab	91.75 b	111.00 a	1	1

Means with same letter in each column are not differed significantly ($p<0.05$)
*Values are means of 20 replicates

Germination Percentage

It was observed that there was no significant ($p<0.05$) difference in the germination percentage of the tested rice varieties. High germination percentage was shown by the variety Bg 300 (90%). Seed should have at least 80% germination to be considered good (Anon. 2003a). Germination test provides essential information to farmers either, to decide the suitability of seeds for sowing or to adjust seed rate to get good stand of crop. High germination percentage is a distinctiveness of good quality seeds. Good seed leads to lower seed rate, higher crop emergence, reduced replanting, more uniform plant stands, and more vigorous early crop growth. All these factors combine to give a 5-20% increase in yield (Anon. 2003a).

Rice planted in three main ways viz. transplanting, row seeding and broadcasting in Sri Lanka. In Batticaloa and Ampara districts, farmers are predominantly practicing broadcasting for crop establishment. In this practice, germination percentage of the seeds play vital role in determining stand establishment. Inferior quality seeds with poor germination percentage create additional expenditure to the farmers for the process of gap filling. As such, farmers give preference to good quality seeds with high germination percentage. From this study, it could

be stated that, all the varieties of rice tested in this trial have better germination percentage.

Lodging assessment

It was found that there was no significant ($p<0.05$) difference in the degree of lodging among the tested varieties. It was also noticed that, no lodging was observed among the treatments at both dough and mature stages. Lodging is a common problem in rice cultivation. A good variety should resistant to lodging under normal farmer management (Anon. 2003b). Increasing the above ground biomass is one of the major breeding objectives of rice development programs. To with stand increased panicle weight new rice varieties should have short and sturdy culms, unless it would lead to lodging. Lodging leads to greater yield loss because it reduces the rate of assimilate translocation form leaves (source) to grains (sink). It also creates difficulties in both manual and machine harvesting. Consequently, farmers prefer lodging resistant varieties for their cultivation. According to table 1, it could be stated that all the rice varieties tested in this experiment are resistant lodging.

Number of tillers per plant

The test variety 'Bw 03.1063' produced high number of tillers (4.5) per plant in this trial. It was significantly higher than the check varieties 'Bg 300' and 'Bg 305'. In this trial, tiller number has been increased from emergence. However, remarkable differences were observed in the rate of tiller production among the test varieties. Test variety 'Bw 03.1063' showed high rate of tiller production than the other varieties. Number of tillers produced by a particular variety is a genetic character and it could be influenced by several environmental conditions such as spacing, fertilizer level of soil, climatic conditions of the growing area, etc. It was substantiated by Yamakazi (1960), that number of tillers produced per plant is a varietal character influenced by environment.

Number of tillers greatly influence the final yield produced by rice plants. Productive tillers generate additional panicles, which could contribute for the final yield. Several scientists found high correlation between the number of tillers and the final yield of rice. Wu *et al.*, (1998), stated that the high yield of rice variety resulted from its greater tillering ability. Higher number of tillers at the flowering stage therefore is a beneficial feature, which can contribute to yield. From Table 1, it could be stated that test varieties At 676 and Bw 03.1063 could be the best with regard to the production of number of tillers per plant at flowering stage.

Days to 50% heading and 85% maturity

Test varieties 'At 307' and 'At 676' took significantly ($p<0.05$) short duration (81 days) to reach 50% heading and varieties 'At 676' and 'Bg 02. 465' were taken short period (106 days) to reach 85% physiological maturity. The number of days taken by these varieties is significantly ($p<0.05$) lower than the days taken by check varieties to reach 50% heading and 85% maturity respectively. Days to 50% heading refers the number of days between sowing to emergence of 50% panicle and days to 85% maturity denotes number of days had taken by the crop to produce 85% spikelets per panicle turned to golden brown in colour and attained physiological maturity.

Reduction in the number of days taken to reach days for 50% heading and 85% maturity are the characters of early maturing varieties. The varieties with less than 140 days were considered as early maturing varieties (Poehlman, 1977). Short duration varieties could contribute to increase cropping intensity. Rice is cultivated in two main seasons but the cropping intensity for rice is 119% (Anon., 2000).

Early maturing varieties are preferred by the farmers for the cultivation during *Yala* season. The level of risk is highest during this season. Shortage of irrigation water, higher incidence of pest and diseases, and elevated temperature are some common problems faced by farmers during *Yala* season cultivation. To avoid these obstacles the cultivating varieties should have short duration of growth. Test variety 'At 676' took short duration to reach 50% heading and 85% maturity. This variety showed the potential of early maturity than the other entries evaluated.

Yield

High yield (1794 kg ha^{-1}) was obtained from the test variety, Bw 03.1063, followed by 'Bg 300' (1716 kg ha^{-1}). 'At 676' has produced second high yield (1797.5 kg ha^{-1}) among the test varieties in this trial. There was no significant difference in the yield produced by Bw 03.1063, 'Bg 300' and 'At 676' and were significantly higher than the yield of standard check 'Bg 305'.

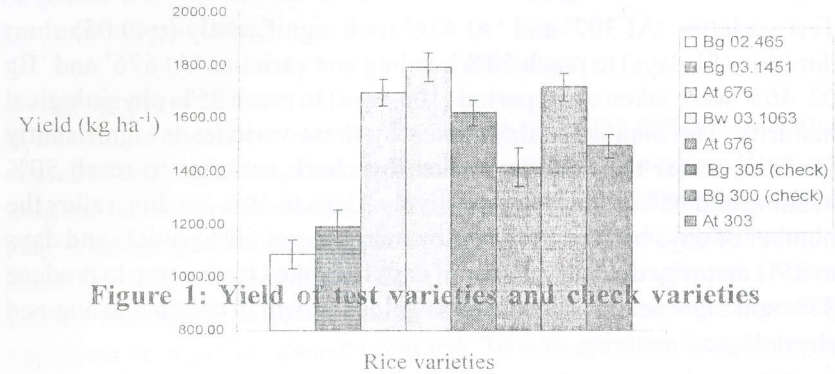

Figure 1: Yield of test varieties and check varieties

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Test variety Bw 03. 1063 produced high number of tillers than other test varieties. It may also be the reason for the highest yield produced by this variety. There is high correlation exists between number of productive tillers in the rice plants and the yield. Test variety 'At 676' produced satisfactory yield in this trial. It also produced greater number of tillers (4.25) in this trial and matured early.

All the test varieties including check varieties produced lower yield. It is due to the heavy water shortage faced by the crops and existence of high temperature (around 32°C) during the cultivation period. Higher temperature could reduce grain yield. It would have decreased percentage of filled spikelets and the number of panicles. Clearly, grain yield starts to decline when mean temperature exceeds 29 °C and grain quality decline linearly with higher temperature (Izumi *et al.*, 2004). Increased temperature during grain filling period decreased the grain weight (Gibson and Paulsen, 1999). The increasing temperature would have limited the source activity through the rapid decrease in photosynthesis. Because in response to high temperature stress, stomata would have closed and subsequent reduction caused in a CO_2 intake.

Water stress is another factor, which could reduce yield. Adequate soil moisture, provided through timely irrigation or precipitation is essential for successful crop production. Soil water deficit is common in the production of most crops and it has a substantial negative impact on growth and development (Lecoeur and Sinclair, 1996). The most obvious effects of water stress are reduction in plant size, leaf area and crop yield. Therefore, high temperature and water stress prevailed during the experimental period may be the reason for the reduction in yield.

CONCLUSIONS

The overall results of this trial suggest that test variety 'At 676' is suitable for cultivation in the Batticaloa district during *Yala* season. However, further studies such as cultivation during *Maha* season, performance under farmers' field condition and suitability of this variety under different agronomic practices are needed to ensure its potentiality.

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