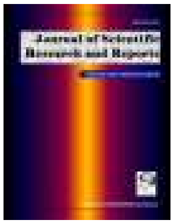

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Effect of Different Levels of Inorganic Fertilizer on Filled Grain Percentage of 50 Sri Lankan Traditional Rice Cultivars

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Authors' contributions

This work was carried out in collaboration between both authors. Author ALR designed the study and wrote the first draft of the manuscript. Author UGSA collected the data, managed the literature searches, tabulated the data. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: To study the different levels of inorganic fertilizer on filled grain percentage of fifty Sri Lankan traditional rice cultivars.
Study Design: RCBD with four replicates. Twenty plants of each replicate were evaluated.
Place and Duration of Study: A field experiment was carried out during 2011/2012 *Maha* season and 2012 *Yala* season at Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka
Methodology: Four levels of inorganic fertilizers were used: No fertilizer, half of the recommended dose, recommended dose and twice the recommended dose. Ten day old seedlings were transplanted in rows with 15 cm X 20 cm spacing according to the randomized complete block design. Data were collected from 80 plants of the middle row. Filled grain percentage/panicle and total biomass (g/plant) were measured after harvesting. ANOVA was performed to see the significant effect of fertilizer on filled grain percentage.
Results: The highest filled grain percentage (89.94%) was observed at twice the recommended

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dose in cultivar Palasithari 601 while the lowest filled grain percentage was 13.737% in rice cultivar Murunga wee at x ½ recommended dose. Hondarawala recorded the highest filled grain percentage at no fertilizer condition (86.3%). Under half recommended dose Kotathavalu, Herath Banda, Kottakaram, Karayal, Kirinaran recorded the highest filled grain percentages. Dewaredderi performed well under the recommended dose of fertilizer

Conclusion: Traditional rice cultivars respond differently to fertilizer in grain filling.

Keywords: Fertilizer; filled grain percentage; no fertilizer; traditional rice cultivars.

1. INTRODUCTION

Sri Lanka paddy cultivation provides livelihood opportunities for more than 1.8 million farmers [1]. At the onset of green revolution farmers initiated cultivation of high yielding varieties instead of traditional rice varieties. High yielding varieties are highly responsive to inorganic fertilizers [1]. Inorganic fertilizers release nutrients in readily soluble mode within soil solution. These are instantly available as plant nutrients [2]. Imbalanced fertilizer application, especially in wet season, creates more severe diseases and lodging resulting in low efficiency of nitrogen fertilizer application [3]. Fertilizer consumption depends on rice variety, soil conditions and farmer practices [3]. Along with improved cultural management, the use of balanced fertilizer is one of the most important aspects for increased crop productivity [4].

Sri Lankan traditional rice gene pool has various biotic and abiotic stress tolerant traits. Some of those cultivars have already been studied for abiotic stress tolerances such as drought, salinity and submergence [5,6]. There are potential rice cultivars that can be directly introduced into agricultural fields or that can be used as future breeding materials. Less yield of traditional rice cultivars become a major constraint in such processes [7,8]. Fertilizers act as a major factor affecting grain yield and quality [9]. The yield of traditional rice cultivars can be increased by altering the fertilizer levels [9,8]. Rice grain filling is a critical and dynamic factor that determines the grain yield [10,11]. Many factors affect on filled grain percentage such as climate, soil, variety, fertilizer application and insect and pest attacks [12]. Among these factors, variety, fertilizer, and irrigation are the most prominent factors while varietal improvement contributes about 40% of the total yield increment [13]. Present study was carried out to understand the effect of fertilizer on filled grain percentage of some traditional rice cultivars in Sri Lanka.

2. MATERIALS AND METHODS

Fifty traditional rice cultivars listed in Table 1 were germinated and planted in nursery beds. Ten days old seedlings were transplanted in the field at Faculty of Agriculture, in rows with 15 cm X 20 cm spacing according to the complete randomized block design with four replicates. Each replicate consisted of three lines and each line contained 20 plants. Four different fertilizer doses were applied: No fertilizer, half of the recommended dose, recommended dose, twice the recommended dose. The recommended fertilizer dose for improved rice cultivars has been introduced by Faculty of Agriculture, University of Ruhuna, Sri Lanka was Basal Dressing: Urea 50 Kg/ha, TSP 62.5 Kg/ha, MOP 50 Kg/ha and Top Dressing: Urea 37.5 Kg/ha – 2 weeks after planting and 8 weeks after planting. Filled grain percentage was calculated as follows.

$$\text{Filled grain percentage} = \frac{\text{Number of filled grains per panicle}}{\text{Number of grains per panicle}} \times 100$$

Data were statistically analyzed by ANOVA and mean separation was done by DMRT groupings using SAS statistical software [14].

3. RESULTS AND DISCUSSION

According to ANOVA filled grain percentage was significantly differed in four levels of fertilizer. This finding is supported with the finding of Ahmed et al. [4] and Awan et al. [15] where they reported that nitrogen fertilizer management significantly affects the number of filled grains per panicle. The filled grain percentage ranged from 13.737% to 89.935%. The recorded highest filled grain percentage was 89.935% at twice the recommended dose in cultivar Palasithari 601while the lowest filled grain percentage was 13.737% in rice cultivar Murungawee at ½ recommended dose.

Filled grain percentage in rice is reported to increase with the fertilizer application [16]. Rice cultivars Handiran and Sudu Karayal increased their filled grain percentage from zero fertilizer to twice the recommended dose linearly. Their highest potential yield must be gained with more fertilizer applications. However, application of more fertilizer is not recommended because of environmental safety issues.

Rice cultivars Kotathavalu, Herath banda, Kottakaram, Dewaredderi, Pokuru Samba, Rata wee, Rajes, Madoluwa, Giress, Karayal, Halabewa, Yakada wee and Heendik Wee reached their maximum potential filled grain percentage at half of the recommended dose or at recommended dose. Yield increment of these cultivars above this level must be gained from a genetic improvement such as out crossing.

There was an interaction in between fertilizer level and rice cultivar. Level of fertilizer responsiveness also differed from cultivar to cultivar (Table 1). It is also well known that a variety shows different fertilizer responsiveness between wet and dry seasons and also there may exist differences among locations and years of experiments [17].

Among the tested traditional rice cultivars, Hondarawala (86.355%), Kotathavalu (84.166%), Kotathavalu (86.219%) and Palasithari 601(89.935%) recorded the highest filled grain percentages at no fertilizer, ½ of the recommended fertilizer, recommended fertilizer and twice recommended fertilizer levels respectively. Cultivars Kalu Handiran, Dena wee, Hondarawala, Podisayam, Heendik Wee and Polayal recorded the highest filled grain percentage at no fertilizer level. Dry matter partitioning of these rice cultivars is not economical, and fertilizer can’t increase yield. Response of Dandumara in grain filling at fertilizer alteration is unique. Its highest filled grain percentage was recorded at the twice the recommended dose while the harvest index was the same at no fertilizer level and the twice the recommended level. Its dry matter partitioning in between sink and source has been unchanged with fertilizer. Among tested traditional rice cultivars Dandumara, Sudu Goda wee, Kiri Naran, Karayal, Akuramboda, Puwakmalata Samba, Palasithari 601, Murungakayan 3, Suduru, Rata wee, Ingrisi wee, Ranruwan, Suduru Samba, Handiran, Gunaratna, Polayal, Tissa wee, Sudu Karayal, Naudu wee, Kokuvellai, Murunga wee, and Lumbini recorded the highest filled grain percentage at twice the recommended dose proving their capacity to produce many grains when the sufficient nutrients are provided while managing its bio mass production compare to that of grain production (biomass data were not shown).

Table 1. Filled grain percentage of individual rice cultivar at four different levels of fertilizer

Cultivar	Filled grain percentage			
	No fertilizer	**x1/2 rec. dose**	**Rec. dose**	**x2 rec. dose**
Kaluhandiran	63.161^{a}	55.488^{b}	51.505^{c}	47.408^{d}
Kirikara	53.955^{b}	60.937^{ab}	64.913^{a}	60.128^{ab}
Kotathavalu	76.185^{b}	84.166^{a}	86.219^{a}	69.127^{c}
Dena wee	70.12^{a}	69.829^{a}	69.284^{a}	62.387^{a}
Herath Banda	69.151^{b}	79.069^{a}	69.829^{b}	49.68^{c}
Hondarawala	86.355^{a}	63.864^{c}	81.614^{b}	79.069^{b}
Kottakaram	75.759^{b}	80.886^{a}	66.825^{c}	77.486^{ab}
Dandumara	70.783^{b}	55.367^{c}	64.752^{b}	85.119^{a}
Karayal	81.125^{b}	78.603^{b}	44.672^{c}	87.121^{a}
Dewaredderi	48.302^{c}	43.927^{c}	87.969^{a}	78.894^{b}
Sudu wee	69.256^{b}	27.683^{d}	61.588^{c}	86.918^{a}
Sudu Goda wee	65.876^{b}	28.319^{c}	68.752^{b}	75.803^{a}
KiriNaran	59.384^{c}	82.129^{a}	68.525^{b}	81.204^{a}
Karayal	56.875^{b}	37.911^{c}	71.309^{a}	74.156^{a}
Akuramboda	64.394^{c}	36.053^{d}	78.615^{b}	88.764^{a}
Puwakmalata Samba	58.101^{c}	27.775^{d}	67.995^{b}	79.441^{a}
Palasithari 601	80.928^{a}	33.695^{d}	72.479^{c}	89.935^{a}
Murungakayan 3	62.564^{c}	22.984^{d}	65.598^{b}	80.966^{a}
Murungakayan 101	60.946^{c}	17.449^{d}	63.634^{b}	77.684^{a}
Bala Ma wee	74.219^{ab}	38.594^{c}	72.968^{b}	78.054^{a}
Pokuru Samba	70.388^{c}	58.406^{d}	80.55^{a}	78.525^{b}
Rata wee	64.149^{c}	45.136^{d}	77.592^{a}	67.287^{b}

Table 1 continued………………

Suduru	52.175^{c}	33.391^{d}	70.550^{b}	84.366^{a}
Ingrisi wee	53.737^{c}	32.497^{d}	72.675^{b}	83.616^{a}
Kotathavalu	50.843^{c}	31.849^{d}	82.527^{a}	76.867^{b}
Kalu Karayal	54.547^{b}	36.085^{c}	83.643^{a}	86.370^{a}
Ranruwan	49.974^{c}	29.663^{d}	75.87^{b}	89.261^{a}
Rajes	54.514^{c}	37.068^{d}	76.378^{a}	62.213^{b}
Madoluwa	53.303^{c}	35.264^{d}	75.536^{a}	68.852^{b}
Suduru Samba	50.692^{c}	31.057^{d}	79.789^{b}	87.712^{a}
Handiran	28.001^{d}	38.381^{c}	79.833^{b}	84.552^{a}
Gunaratna	69.527^{b}	26.417^{c}	69.527^{b}	75.149^{a}
Polayal	66.914^{a}	54.227^{b}	68.336^{a}	63.334^{a}
Tissa wee	56.264^{b}	55.465^{b}	62.569^{b}	83.067^{a}
Sudu Karayal	29.828^{c}	55.101^{b}	76.504^{a}	83.000^{a}
Podisayam	73.457^{a}	61.690^{b}	73.457^{a}	74.863^{a}
Giress	62.559^{c}	50.571^{d}	83.884^{a}	72.597^{b}
Naudu wee	78.499^{b}	35.612^{b}	79.938^{b}	82.7289^{a}
Kokuvellai	56.299^{c}	41.332^{d}	81.178^{b}	83.653^{a}
Karayal	59.364^{c}	46.590^{d}	79.764^{a}	74.992^{b}
Murunga wee	24.409^{c}	13.737^{d}	69.529^{b}	81.979^{a}
Matara wee	64.935^{b}	50.814^{c}	80.754^{a}	79.243^{a}
Kaharamana	51.198^{b}	36.447^{c}	67.101^{a}	63.479^{a}
Karabewa	55.495^{c}	29.709^{d}	76.058^{b}	80.086^{a}
Halabewa	68.369^{c}	25.818^{d}	79.260^{a}	75.871^{b}
Yakada wee	58.234^{b}	29.372^{c}	67.082^{a}	58.709^{b}
Lumbini	79.827^{b}	33.680^{d}	70.735^{c}	88.199^{a}
Polayal	47.942^{a}	19.266^{d}	36.429^{b}	30.358^{c}
Heendik wee	72.129^{a}	70.215^{a}	42.263^{b}	68.345^{a}
Kahata Samba	80.244^{b}	51.597^{c}	78.252^{b}	88.459^{a}

Mean values of each genotype are given and the highest value is highlighted x1/2 rec: Recommended dose of fertilizer, x1/2 rec. dose: Half of the recommended dose of fertilizer, Rec. dose" Recommended dose of fertilizer, x 2 rec. dose: Twice recommended dose Different letters in the same row indicate significant differences

Attribution of grain filling in rice cultivar Polayal with increased fertilizer was very poor. Grain filling of Polayal was gradually decreased with increased fertilizer application. This would be due to partial canopy shading explained by Yoshida [12]. At grain filling stage, about 40 to 50 percent of total biomass is deposited into the grains [17]. Crops shaded during the ripening period reduce the filled grain percentage because of high amount of partially filled grains. There was an interaction in between rice cultivar and fertilizer level in filled grain percentage. Rice cultivar Dena wee was not responsive for fertilizer in grain filling. The only strategy to improve the yield of this cultivar is a genetic manipulation towards higher grain filling. Some rice cultivars such as Kotathavalu, Herath banda, Kottakaram, Dewaredderi, Pokuru Samba, Rata wee, Rajes, Madoluwa, Giress, Karayal, Halabewa, Yakada Wee and Heendik Wee reached the highest potential grain filling percentage within the tested fertilizer ranges while there were some rice cultivars such as Handiran and Sudu Karayal that did not reach to their maximum grain filling percentage in the tested fertilizer range. The filled grain percentage of rice cultivars Dewaredderi, Sudu wee, Sudu Goda Wee, Kiri Naran, Karayal, Pokuru Samba, Rata wee, Kotathavalu, Rajes, Madoluwa, Gires, Karayal, Halabewa and Yakada Wee increased in recommended fertilizer level while Heendik Wee, Kottakaram, Kiri Naran and Herath Banda recorded the highest filled grain percentages in half of the recommended dose.

4. CONCLUSION

Traditional rice cultivars responded differently on grain filling at different fertilizer levels. However majority of rice cultivars increased the filled grain percentage with the fertilizer. The best fertilizer level for individual rice cultivar could be identified from the findings of the present study. Rice cultivars such as Kalu Handiran, Dena wee, Hondarawala, Podisayam, Heendik Wee and Polayal can be integrated in to organic farming systems hence they recorded the maximum grain filling at no fertilizer level. Rice cultivars such as Dewaredderi, Sudu wee, Sudu Goda Wee, Karayal, Pokuru Samba, Rata wee, Kotathavalu, Rajes, Madoluwa, Giress, Karayal, Halabewa and Yakada Wee can be integrated in to the present rice cultivation system in Sri Lanka hence they recorded the maximum filled grain percentages at the recommended fertilizer level.

However, concerning the environmental hazards of inorganic fertilizers, application of much fertilizer is not recommended.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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