USE OF *Salvinia molesta* AS A PHOSPHORUS SOURCE ON THE GROWTH PERFORMANCE OF RICE

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INTRODUCTION

Phosphorous (P) is one of the major nutrients for the plant and is added as chemical fertilizers, which are derived from phosphate rocks. Approximately 60% of the P applied to cropland comes from a non-renewable source of phosphate rocks (Cooper *et al*, 2011). Phosphate rocks classify asa finite resource because it takes 10 to 100 million years to cycle (Cordell *et al*, 2008). In Sri Lanka, P fertilizers are applied for rice (*Oryza sativa*) which affects tillering dynamics, leafelongation rate, and flowering, ripening and root development (Luquet *et al*, 2015). Therefore, it is necessary to maintain soil phosphorus availability to ensure rice productivity and finding alternative sources of P and management of the P cycle is important for future phosphorus scarcity.

Farm effluents have a high concentration of P and are a source of eutrophication of water bodies. Therefore, plant-based removal strategies have been introduced to remove the P from water streams(Baker *et al*, 2015). *Salvinia molesta* is one of the aquatic plants that has been used to remediate P from wastewater-based systems and the mean efficiency of removal of total P from wastewater has been recorded as 72.1% (Henry-silva *et al*, 2006). The aim of this study was to determine the growth performance of the rice plant (*Oryza sativa*) with *Salvinia molesta* as its phosphorus source.

METHODOLOGY

Preparation of *S. molesta* fertilizer

S. molesta was collected from open tanks and cleaned with running tap water to remove surface dirt. *S. molesta* (200.00 g) was introduced to the cattle farm effluent (3.5 L) to absorb P from cattle farm effluent. The *S. molesta* enriched with P was washed with tap water followed by air drying. Plants were oven-dried at 70 °C for 2 days and the oven-dried plant material was ground and powdered(200 mm). The amount of P in *S. molesta* powder was determined by the Ascorbic acid bluemethod (Murphy and Riley, 1962).

Preparation of experimental pots

Soil was collected from the top 10 cm layer of a paddy field in Dambulla and initial soil parameters, available phosphate, soil pH and Electrical Conductivity (EC) were measured. Plastic pots (25 cm height, 26 cm diameter) were water sealed by a polythene cover. Air-dried soil was added to each pot and the water level was maintained at 5 cm above soil level. A tray was kept beneath pots to capture leaking water which was poured back into the pot.

Method of planting

Seeds of BG 4/91 were obtained from the Rice Research and Development Institute, Bathalegoda, Ibbagamuwa, Sri Lanka. These seeds were soaked in water for 24 hours for germination. After two weeks, three uniform thinned seedlings were placed in each labeled pot and the initial heights of the plants were measured

Treatments

Two days after planting, fertilizer was applied. Four treatments; T1 (Urea + MOP + TSP), T2 (Urea + MOP + Salvinia powder), T3 (Urea + MOP) and T4 (without adding any fertilizer) were done as five replicates. Treatments were done by following the recommendations by the Department of Agriculture (DOA) in Sri Lanka and the required amounts of fertilizers were calculated per pot area.

Table 1: Treatment Chart according to the time period

Days after planting	T1	T2	T3 (Control)	T4 (Blank)
2	TSP	Salvinia	Salvinia	-
16	Urea+MOP	Urea+MOP	Urea+MOP+BF	Urea+MOP
30	Urea	Urea	Urea	Urea
44	Urea+MOP	Urea+MOP	Urea+MOP+BF	Urea+MOP

Table 2: Fertilizer required for 0.05 m^2 per pot area

Days after planting	Urea(g) $\pm 0.0001(g)$	MOP(g) ± 0.0001 (g)	TSP (g) $\pm$ 0.0001/g	BF (mL) ± 0.02/mL	Salvinia powder $\pm$ 0.0001/g
2	-	-	0.1250	-	0.06
16	0.3000	0.1125	-	0.006	-
30	0.5250	-	-	-	-
44	0.3250	0.1525	-	0.006	-

Measurements of growth parameters

Plant height (from culm base to tip of the longest leaf), number of leaves per plant, number oftillers and the width of leaves per plant (the longest leaf in the plant) were measured every two weeks from the day after planting. After three months, all the plants were harvested as shoots, roots, and seeds separately to determine the available phosphate concentration and total phosphate concentration of shoots and roots.

Phosphorus analysis of plant and soil

The available phosphate concentration and the total phosphate concentration were determined for soil, shoot and root of each pot separately to identify the effect of phosphorus absorption by the shoot and root from the soil. The total phosphate concentrations were analyzed followed by wet digestion. Wet digestion was conducted for the shoot, root, and soil using a digestion mixture of H_2O_2, H_2SO_4, Se, and Li_2SO_4 at 360 °C for 2.5 hours. The available phosphate concentrations were analyzed using ascorbic acid blue method with a UV spectrophotometer at 750 nm.

Data analysis

Statistical parameters and comparison studies were done using the Minitab 17 statistical package.

RESULTS AND DISCUSSION

The available P content in the collected soil was 99.2 ± 2.4 mg kg^{-1} of the dry weight of soil and the soil used for this study contains a high concentration of P. Kulasinghe *et al*, (2020) have recorded that the minimum amount of available P in soil was 10 mg kg^{-1}. The initial soil pH was 6.30 ± 0.04 and it was in the range of optimum soil pH recommended for rice under dry conditions (5.5 – 6.5) and flooded conditions (5.5 -7.2) (Massawe *et al*, 2017). The electrical conductivity (EC) of the initial soil sample was 2.27 ± 0.03 dS m^{-1}. The most sensitive value range of soil EC is 0.6 to 2.5 dS m^{-1} (Smith *et al*, 1996). Therefore, the initial pH, EC and available P in the soil indicated that it is suitable for agricultural fields. Kalala *et al*, (2016) has introduced the optimum concentration of P and potassium (K) in soil as 40 mg kg^{-1} and 400 mg kg^{-1} of soil respectively and the soil used of this study was around 99.2 mg kg^{-1} and it was more than enough to grow the plant properly.(Kalala *et al*, 2016).

The initial P concentration of cattle farm effluent, which was used to enrich the *S. molesta* with P for this study was 65.13 mg kg^{-1} and was concentrated up to 1.26 % of P in *S. molesta* on a dry matter basis after 21 days. Total concentrations of plant nutrients P, potassium (K) and nitrogen (N)are shown in Table 3.

Table 3: Nutrient composition (mean ± SD) of ground *S. molesta* after treatment with cattle farmeffluent for 21 days. (DM – dry matter)

Parameter	After treatment
Total Phosphorus (g kg^{-1})	12.61 ± 0.81
Total Potassium (g kg^{-1})	13.67 ± 0.17
Total Nitrogen (mg kg^{-1})	32.85 ± 0.38

The available P after harvesting in T1 soil (107 ± 2 mg kg^{-1}) treated with TSP was higher than all the other treatments and the initially measured available P in soil.

The growth parameters of the *O. sativa* with different treatments were measured at different time intervals from the day after planting (DAP). Figure 1 shows the mean and the standard deviation (SD) of the height.

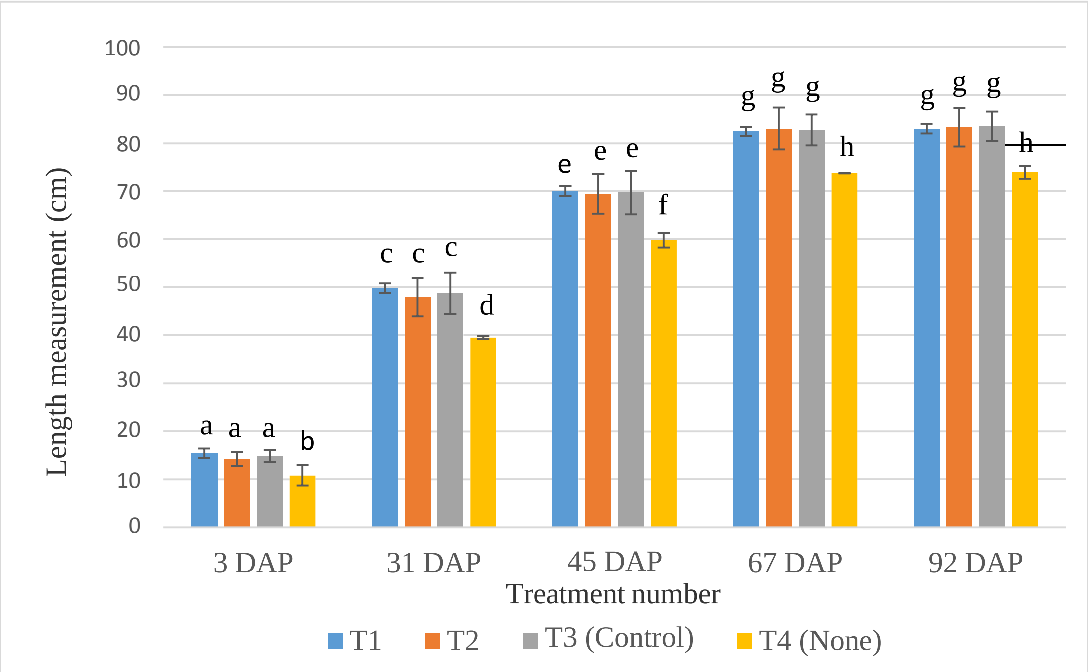

Figure 1: The average height (cm) of the *O. sativa* for different treatments

According to the results given in Figure 1, the length of the plant gradually increased with time with similar trends for the four treatments. The set of data recorded for the length of four treatmentsis normally distributed and the data obtained after the one-way ANOVA ($p < 0.05$). According to data, the length of the *O.sativa* grown in T4 soil was significantly lower than in the other treatments and there was no significant difference among these treatments (T1, T2 and T3). There was a high amount of P in soil, which was used, but growth performance will depend on fertilizers.

The ranges for the total number of seeds in the *O.sativa* under different treatments were 348-605 for T1, 338-593 for T2, 323-445 for T3 (Control) and 235-263 for the T4 (Blank), respectively. The average values for T1, T2, and T3 treatments showed no significant difference but were significantly higher than the T4 treatment, which had a significantly lower dry weight (Figure 2).

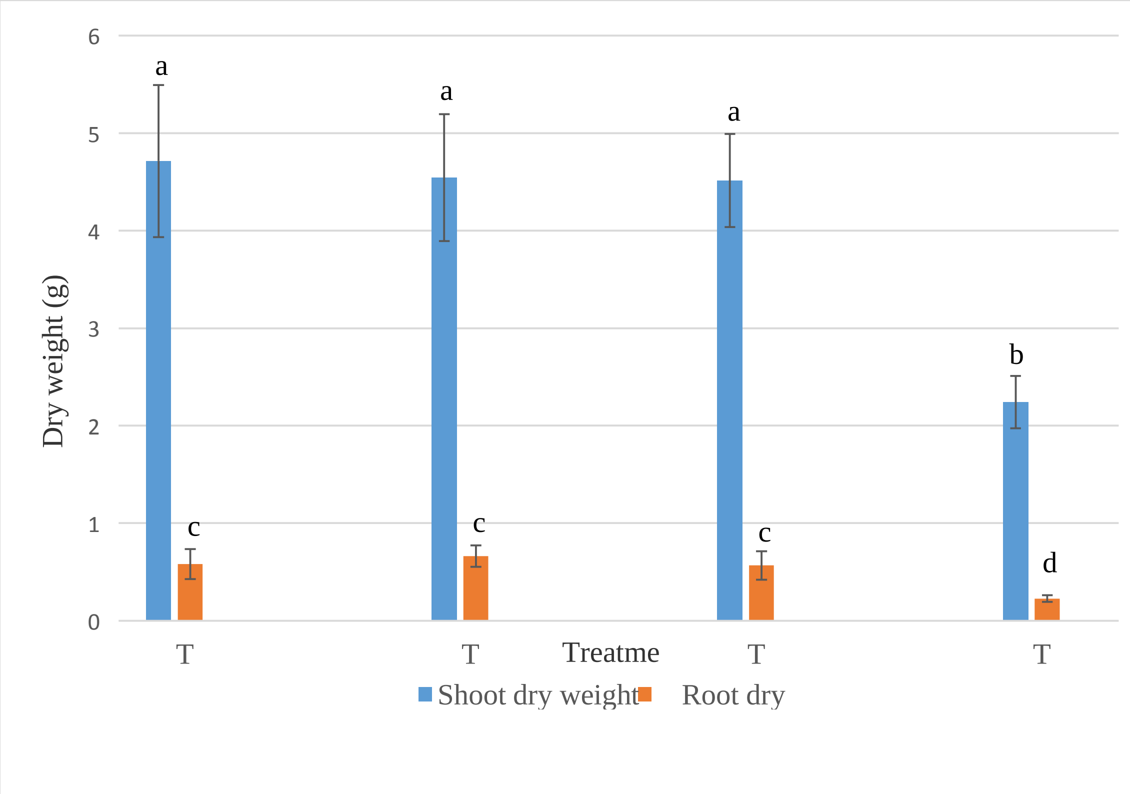

Figure 2: Dry weight of the plant (g) for different treatments

Even though there was no significant difference among the three methods with the growth parameters, the percentage of the fertilized seeds was significantly higher in T3 (Control) treatment than in the other three treatments (Table 4). It seems to be, as P concentration is more than enough to grow the rice properly. Even though P fertilizer did not add T3 treatment, it contains other nutrients (potassium and nitrogen) similar to T1 and T2. In literature indicates that potassium is very important to improve the grain quality (yield) of rice and potassium absorption is faster than nitrogen and phosphorus from the soil (Atapattu *et al*, 2018).

Table 4: Fertilized seeds, number of tillers and number of leaves with different treatments

Treatments	Percentage of fertilized seeds (yield) Mean ± SD*	Number of tillers Mean ± SD	Number of leaves Mean ± SD

T1	29 ± 3[bc]	2.46 ± 0.50	6.80 ± 1.39
T2	25±2[c]	2.26 ± 0.28	7.28 ± 0.99
T3 (Control)	77 ± 5[a]	1.96 ± 0.43	6.06 ± 0.89
T4 (Blank)	20 ± 1[d]	1.50 ± 0.70	4.50 ± 0.28

*Different letters indicate the significant difference among the different treatments (one-way ANOVA, $p < 0.05$)

According to Table 4, the number of tiller and the number of leaves were almost similar for soils treated with T1, T2, and T3 treatments compared to T4, and the average values were higher in T1, T2, and T3 treatments than T4. The treatments T1, T2, and T3 showed significantly higher yield than T4 and there was no significant difference between TSP added treatment and the Salvinia added treatment for the percentage yield of seeds fertilized, while T3 without the addition of any phosphate fertilizer showed a highest percentage of yield. The plants were harvested exactly after three months, before they matured. Therefore, it seems to be that the addition of phosphate fertilizer indirectly reduced the N uptake of the plant. The literature shows that the rice growth and early flowing is promoted by P while the N affected the rice yield and the quality of rice (Y. Komoto, 1970). According to D Grunes (1959), N increases the growth of plant tops and concurrently increases the absorption of P. Therefore, future studies are to be conducted to find out the combined effect of N.

CONCLUSIONS/RECOMMENDATIONS

Salvinia plants enriched by P collected from farm effluent can be used as a substitute for TSP for *Oryza sativa*. However, future studies need to be conducted to determine the combined effect of Nand P since the control plants showed a comparatively higher yield than the P fertilizer containing treatments.

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