ASSESSMENT OF SOIL PROPERTIES AND YIELD UNDER DIFFERENT INPUT SYSTEMS IN ALFISOLS FOR RICE (*Oryza sativa* L.) CROP

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INTRODUCTION

Rice (*Oryza sativa* L.) is the major crop grown in Sri Lanka because rice is the staple food crop of Sri Lanka. Rice is cultivated under the two main monsoon seasons *Maha* and *Yala*. Sri Lankan agriculture is characterized by the typical conventional agriculture systems that descend from the green revolution. Here, farmers use external synthetic petroleum-based fertilizer to gain high crop yields without paying attention to its negative effects. Continuous application of synthetic fertilizers in farming practices may hazardously influence the whole environment. (Ranasinghe, 2017). Due to this reason, demand for alternative agriculture practices is increasing throughout the world. Integrated agricultural practices and organic farming could be the most promising sustainable alternatives for conventional agriculture. Since it is the case that most farmlands are under conventional farming, generally most of them are polluted and cannot be used as organic farming lands. Therefore, the time taken for conversion from conventional to organic is known as the transition period (Ranasinghe, 2017).
Therefore, the broad objective of this research is to evaluate the soil fertility related parameters and its relationship to crop yield during the transition period from conventional input systems to alternative systems (integrated nutrient management and organic management) in the rice crop during the *Yala* season.

MATERIALS AND METHODS

A field experiment was conducted during *Yala* season (2019) at the research farm, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura. This is a low land paddy field under DL_{1b} agro-ecological region between latitude 8° 57' 44N and longitude 80° 31' 16E with the mean annual rainfall between 1250 mm to 1750 mm. The largest extent of the land in the dry zone consisted of Reddish Brown Earth (RBE) soil type and certain areas consist of Low Humic Gley (LHG) soil type (Sanjeevani *et al*., 2015).

Experimental layout and treatments

The study was initiated during the *Maha* season 2019. The experimental design was the Randomized Complete Block Design together with six replicates for each treatment combination. Bg300 rice variety was used to cultivate at 120kg/ ha seeding rate. T1- 100% DOA recommendation and weed and pest management were obtained by commercial synthetic pesticides (conventional), T2- 50% reduction of DOA recommendation and organic fertilizers by volume and weed and pest management were obtained by integrated manner (reduced), T3- 100% organic fertilizers and weed and pest management were obtained by commercially available organic botanicals and water management (organic). Compost (10 ton ha^{-1}) and cow dung (5 ton ha^{-1}) were added as organic fertilizers, twice within the season.

Table 1 : Available NPK percentages of organic fertilizers (Compost & Cow dung)

Input type	N %	P %	K %
Compost	0.01	0.03	2.20
Cow dung	0.01	0.01	1.45

Soil sampling and analysis

There were 18 plots and soil samples were collected from the initial stage (prior sowing), 50% heading stage and after harvesting. Each soil sample was analyzed for available phosphorous, microbial biomass carbon, ammonium nitrogen and nitrate nitrogen.

Yield parameters

Number of plants per unit area (90 m^2), number of panicles per plant, number of grains per panicle, filled grain weight, unfilled grain weight, 1000 grain weight and final grain yield was recorded as parameters.

Data analysis

Data was analyzed using the ANOVA procedure in SAS. Means were separated using LSD mean at $P \geq 0.05$.

RESULTS AND DISCUSSION

Available Phosphorous

As experiment conducted in the same field revealed 24 - 62 mg kg^{-1} available P (Vidyarathna *et al*., 2008). Available P expressed significant difference at $P \leq 0.05$ with input system × time interaction. Considering three input systems all over the cropping season conventional and reduced systems do not reflect significant fluctuation with time. Organic system has exhibited gradual increase of available P with the time and at the harvest stage it contained the highest value. Available P change was according to factors such as, fertilizer application, soil reactions, microbial activity, aeration and temperature (Perera and Weerasinghe, 2014). Organic system may contain contrastingly higher value as it might be influenced by reduction of nutrient uptake and with the decomposition nutrients which may release highly at harvest stage.

Microbial Biomass Carbon

MBC shows significant difference at $P \leq 0.05$ with input system × time interaction effect. MBC gradually decreased with the time in conventional system. Initial and harvest stages of reduced and organic systems contained higher MBC. MBC fluctuates significantly among soils with different fertilizer treatments, soil layers and sampling seasons (Ge *et al*., 2010, Nakhro and Dkhar, 2010). At seedling and ripening stages MBC was in higher range and when it comes to mid stage MBC gets into low range. Alternatively, compared organic and reduced input systems it was obvious with them (Ge *et al*., 2010). Higher MBC at initial stage might be influenced by nutrient availability due to previous fertilizer remains. Availability of nutrients for microbes gets lower with plant uptake. Usually, MBC gets higher at harvest stage as a reflection of increased nutrient storage by microorganisms, plant residues, and root secretions (Ge *et al*., 2010). Though organic system should show drastically difference in MBC, in this field it was not obvious. There were very few changes in MBC in the first transition year and it was influenced by low organic matter, depletion of nutrients within soil because still it is not established and enrich (Perera and Weerasinghe, 2014). In reduced system there's significant increase at harvest which might be due to reduction of plant uptake and microbial pool to get available nutrients through fertilizers.

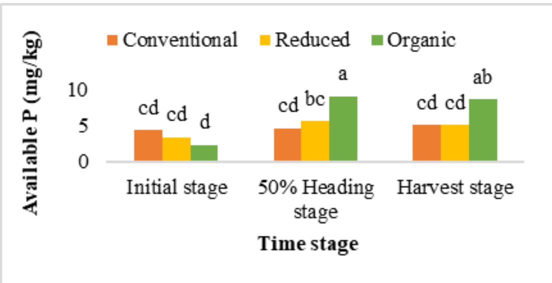

Figure 1: Distribution of input system × time stage interaction effect on soil available Phosphorous

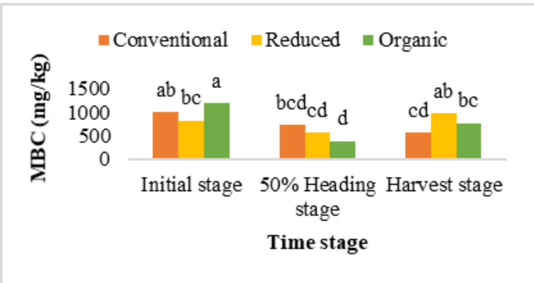

Figure 2: Distribution of input system × time stage interaction effect on MBC

Ammonium Nitrogen

Ammonium N revealed significant difference at P ≤ 0.05 with input system × time stage interaction. At the initial stage, there is no significant difference among three input systems, but when it comes to heading stage conventional input system recorded significantly higher amount of NH_4^+ N compared to other input systems. Initial stage, there was low NH_4^+ N within all input systems, because there was no legume crop or remained crop residual prior to the season. During heading stage, conventional system has been supplied with chemical fertilizers. As it easily releases into available forms, NH_4^+ N content may be significantly increased. Heading stage there's no significant difference with reduced and organic systems. As organic and reduced systems were incorporated with organic manure it takes time to decompose and release nutrient (Perera and Weerasinghe, 2014). Rice crop completed two third of nitrogen requirement after 50% heading therefore conventional system may have excess nutrients (Bender *et al*., 2013, Yoshida, 1981). With slower releasing rate and higher usage of nitrogen, organic system has been recorded low NH_4^+ N.

Nitrate Nitrogen

Nitrate nitrogen revealed significant difference at P ≤ 0.05 with input system × time stage interaction. Heading stage, conventional system recorded significantly higher rate than organic system and at harvest stage organic system recorded significantly highest. Higher NO_3^- N range in the research field than NH_4^+ N happened due to the nitrification. Initially, conventional system contained lower NO_3^- N but it has significantly increased at heading stage. Continuous fertilizer application and nitrification might be the major reason for enhanced soil NO_3^- N. In reduced system it does not show any significant difference. This system gains one half in readily available form and next half in inaccessible form and must decompose to make it available. In organic system, there is no significant increase from initial to mid stage which might influence low rate of nitrification (Krell, 2020). Plant uptake also may cause lowering of the NO_3^- N. But at the harvest stage, it has significantly increased. Decomposing organic manure lowers negative binding sites to NH_4^+ N which may accelerate the nitrification. Organic manure application also cause to increase the nitrification (Yamamuro, 1983).

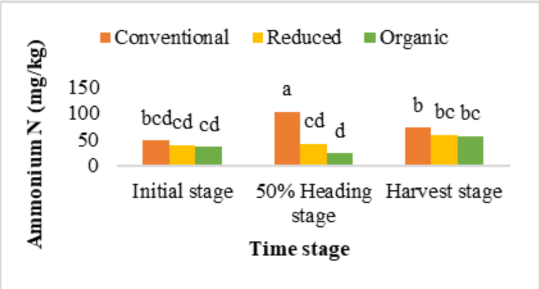

Figure 4: Distribution of input system × time stage interaction effect on soil ammonium Nitrogen

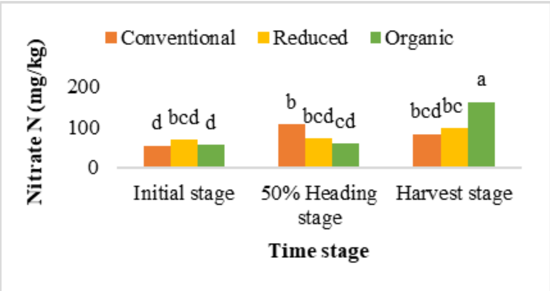

Figure 3: Distribution of input system × time stage interaction effect on soil nitrate Nitrogen

Rice yield parameters

BG 300 rice variety is a 3 month variety, which has 6.5 ton/ha yield potential. Productivity and final grain yield of rice plant is greatly affected by, number of productive tillers, panicles m^{-2}, number of grains per panicle and weight of 1000 grains (Yoshida, 1981). Number of grains per panicle and weight of 1000 grains were only significant at P ≤ 0.05 with the input systems. Highest number of grains per panicle was recorded from conventional input system. Generally, N is the most critical nutrient to all crops and in rice it helps to increase plant height, tillering, panicles, yield (Fageria, 2014), The N requirement is high at before heading compared to ripening stage. When it comes to heading stage, organic field showed a significant lack of available N. Though availability of nutrients at early growth stages is critical, organic management is unable to provide this. Since the field is still under first transition year, lower accumulation of decomposed organic materials might be affected. Organic management has significantly lowest 1000 grain weight. Final grain yield at 14% moisture was significantly different at $P \leq 0.05$ in three input systems. The highest yield (4.9 ton/ha) was recorded from the conventional input system and the lowest yield (2.7 ton/ha) was recorded in organic input system. Therefore, it is obvious that replacing the 50% or half of the DOA recommendation with organic inputs may not harm the final yield. It has proved into BG 352 which produced similar yields in Integrated Nutrient Management and 100% DOA fertilizers for lowland rice in Anuradhapura district (Dissanayake *et al*., 2015). Observing lowest grain yield in organic input system may result because of the first transition year. Usually, a land needs two to three years to be recognized as an organic land and it needs a period of more than two years to stabilize rice productivity within organic input system. Once it has built after a period of time with continuous use of organic nutrients it would remain for longer period (Surekha *et al*., 2013).

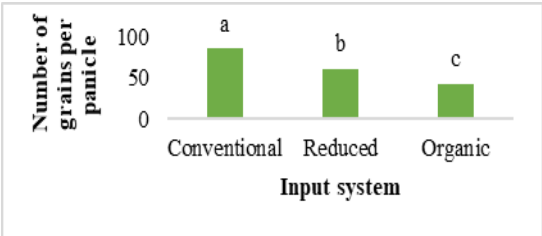

Figure 6: Variation of number of grains per panicle with input systems

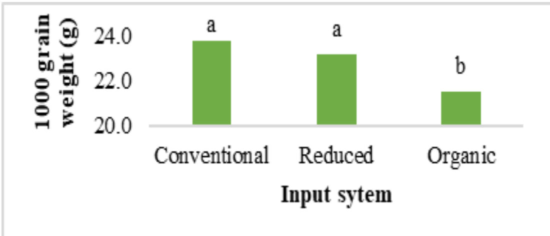

Figure 5: Variation of 1000 grain weight (g) with input systems

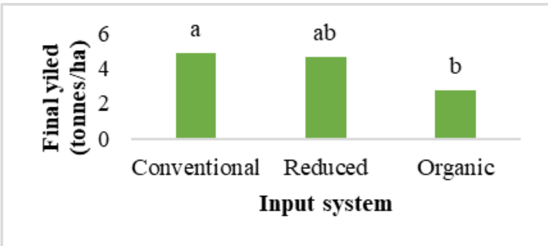

Figure 7: Variation of final yield (ton/ha) at 14% moisture with three input systems

CONCLUSION

Paddy soil needs time to build up desirable soil properties with organic manure application. Nitrate nitrogen and available phosphorous were significantly increased at the organic input system from its' first transition year. Conventional (100% DOA) and reduced (50% DOA + 50% organic manure) input systems produced similar final yields for the rice crop. Therefore, it is recommended to replace 50% synthetic fertilizers with organic manure without much consequences.

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