Research article

Effect of Chicken Manure and Chemical Fertilizer Applications on Growth and Yield of Rice (*Oryza sativa* L.)

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Abstract The field experiment was conducted at Yezin Agricultural University Farm, Yezin, Nay Pyi Taw, during July to November wet season, 2020, to investigate the effects of chicken manure and chemical fertilizer applications on growth, yield and yield components of rice. The experimental design was a randomized complete block (RCB) design with four replications. The four treatments were T1 (control, no application), T2 (80 N, 20 P, 32 K) kg ha^{-1} (recommended rate), T3 (5 ton $ha^{-1}$of chicken manure), and T4 (2.5 ton ha^{-1} of chicken manure + recommended rate of fertilizer). Urea, triple superphosphate and muriate of potash were used as the N, P, and K sources and chicken manure was applied basally. The Sinthukha rice variety was tested. The plant growth parameters were recorded at biweekly intervals and the yield and yield components data were also collected at harvest time. The results show that the combined application of organic manure and recommended rate of fertilizer (T4 treatment) increased the number of panicles $hill^{-1}$, number of spikelets $panicle^{-1}$, filled grain percentage, and harvest index in comparison to other treatments. Moreover, the highest grain yield (6.87 ton ha^{-1}) was observed in T4 treatment and the minimum grain yield (6.09 ton ha^{-1}) was found in T1. Among the four treatments, T2 showed the second highest yield of rice in this study. The combined application of chicken manure and chemical fertilizer (T4) increased grain yield up to 12% over control. The application of chemical fertilizer only (T2) increased yields 7% more than the control. The application of chicken manure (T3) resulted in a 6% yield increase compared to the control. The application of chicken manure and chemical fertilizer (T4) increased yield per hectare by up to 6-12% more than the control. Therefore, the combined application of chicken manure and chemical fertilizer had the greatest effect on improving the yield of Sinthukha rice variety and maintaining soil sustainability.

Keywords chicken manure, chemical fertilizer, rice yield

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food of about 3 billion people, nearly half the world's population, who depend on rice for survival. In many countries, rice accounts for more than 70% of human caloric intake and represents the main source of protein for poor people in all developing countries (Sharma, 2014). Rice cultivation is the principal activity and source of income for millions of households around the world, and several countries in Asia and Africa are highly dependent on rice as a source of foreign exchange earnings and government revenue (FAO, 2014).

Myanmar is the world's sixth-largest rice producing country (Maclean et al., 2013). Rice is grown during the monsoon and summer seasons in Myanmar's four growing zones designated as delta, dry zone, coastal zone, and mountainous areas (Linn and Maenhout, 2019). The total area sown to rice in Myanmar was 7.22 million hectare (ha) with an annual production of 28.01 million metric ton and an average yield of 3.92 MT ha $^{-1}$ in 2018-2019 (MOALI, 2019).

Due to the increasing cost of chemical fertilizers, depletion of soil micronutrients, environmental and health hazards, the use of organic manure in farming has attracted much attention (Ramesh et al., 2005). The adequate fertilizers in rice are fundamental to achieve great productivity. On the other hand, animal manures and green manures are little used as a source of nutrients in rice crops (Schmidt and Knoblauch, 2019). Organic manures are excellent fertilizers, containing nitrogen, phosphorus, potassium and micronutrients essential for the healthy growth of plants. Furthermore, it has numerous benefits due to the balanced supply of nutrients including micronutrients. In agricultural fields, organic manure that is manufactured from animal byproducts has been utilized to overcome environmental pollution and plant productivity reductions that result from the constant utilization of chemical fertilizers (Han et al., 2016).

Organic manure such as poultry manure increases the organic matter (OM) content of soil and in turn releases the plant nutrients in a form available for use (Magkos et al., 2003). It contains essential nutrient elements associated with high photosynthetic activity and thus promotes root and vegetable growth (John et al., 2004). Previous studies have shown that the integration of inorganic fertilizer with organic manure has been more beneficial than the use of either mineral fertilizer or organic manure alone, especially in intensive agricultural production. Therefore, the integrated use of both organic manure and chemical fertilizers can provide the best approach in providing greater stability in production and improving soil fertility status (Islam et al., 2011).

OBJECTIVES

The present study was conducted to investigate the effect of applications of different combinations of chicken manure and chemical fertilizer on growth, yield and yield components of rice and to ascertain the most favorable application rate to improve yield of rice.

MATERIALS AND METHODS

The experiment was conducted in the Yezin Agricultural University Farm Yezin, Nay Pyi Taw, during 2020 wet season, from July to November. Yezin is located at 19º 52' N and 96º 37' E with an altitude of 103 meters above sea level. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four treatments and four replications. The individual plot sizes were (5 x 5) m^2. Double bands provided separation between plots. Treated plots were separated about 1m from surrounding fields to prevent contamination which may have an effect on treatments, such as any mixing of fertilizers during irrigation. The treatments were T1 (control, no fertilizer application), T2 (80 N, 20 P, 32 K) kg ha^{-1} (recommended rate), T3 (5 ton ha^{-1}of chicken manure), T4 (2.5 ton ha^{-1} of chicken manure + fertilizer at the recommended rate). Urea, triple superphosphate and muriate of potash were used as N, P and K sources. Chicken manure and triple superphosphate and potash fertilizers were applied basally. Urea fertilizer was applied equally at three different stages (basal, active tillering and panicle initiation). The soil texture of the experimental field was sandy loam, had a moderately acid (pH 5.8), was low in organic matter (1.09 %), had medium levels of available nitrogen (87 ppm), was slightly low in available phosphorus (3.5 ppm), low in available potassium (104 ppm) and low in available sulphur (36 ppm).

Sinthukha rice was the variety tested. The twenty day old seedlings were transplanted and spaced at 20 cm × 20 cm. Irrigation was provided during the growing season as necessary. Weed control and other management procedures were regularly undertaken, especially at the early stages of growth. Harvesting was at 98 days after transplanting (DAT).

Plant growth parameters such as plant height and number of tillers per hill from five randomly selected sample hills in each plot were collected from 14 DAT to 98 DAT at biweekly intervals. The yield and yield components were recorded at harvesting stage and grain yield was measured from a 1 m^2 centrally located area in each plot.

The collected data were analyzed statistically using Analysis of Variance (ANOVA) and mean values were compared by least significant difference (LSD) at 5% probability level. All statistical analyses used statistix 8.0 software.

RESULTS AND DISCUSSION

Plant height was measured starting from 14 DAT to 98 DAT at biweekly intervals (Fig.1). Plant heights were increased significantly under all treatments, from 14 DAT to 42 DAT. There was no significant difference in plant heights in all treatments at 28 DAT, 56 DAT, 70 DAT, 84 DAT and 98 DAT. The tallest plants (116.91 cm) grew subject to T4 treatment, followed by T2 treatment (114.55 cm), and T3 treatment (111.59 cm) at 98 DAT. The shortest plant was found in T1 treatment (110.53 cm). These differences may be due to the effects of the combined applications of organic manure and chemical fertilizer, releasing macronutrients and micronutrients to the plants.

The number of tillers per hill was recorded from 14 DAT to 98 DAT at biweekly intervals (Fig. 2). The number of tillers per hill did not increase significantly with the application of chicken manure and chemical fertilizer application at the different growth stages of rice. The highest number of tillers per hill occurred in T4 (16.15) followed by T2 (14.25), T3 (13.75) and the lowest value was in T1(13.40) at 98 DAT. It was similarly reported by Nayak et al. (2007), that a significant increase in effective tillers hill $^{-1}$ was obtained with the applications of organic manure and chemical fertilizer.

The effect of chicken manure and chemical fertilizer application on yield and yield components are described in Table. 1. There was no significant variation in number of panicles per hill for each treatment. The number of panicles per hill ranged from 10.80 to 12.55. The maximum number of panicles per hill occurred in T4 (12.55) followed by T2 (12.50) and T3 (11.35) and the minimum number of panicles per hill was in T1 (10.80). The greatest increase in the number of panicles per hill occurred with the combined application of chicken manure and chemical fertilizer.

There was not a significant variation in panicle length among the different treatments. The panicle length ranged (ranges) from 22.78 to 23.92 cm. The highest panicle length (23.92cm) was observed in the T4 and the lowest panicle length (22.78 cm) was in T1. The increase in panicle length in response to combined application of organic and inorganic fertilizers (T4 treatment) may be due to the greater availability of macronutrients as well as micronutrients (Awan et al., 2011).

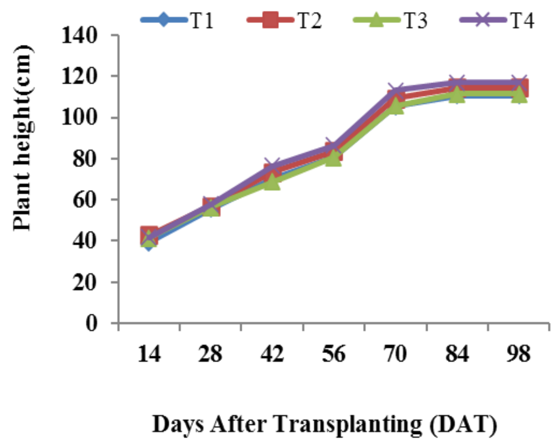

Fig. 1 Influence of chicken manure and chemical fertilizer applications on mean values of plant height of rice

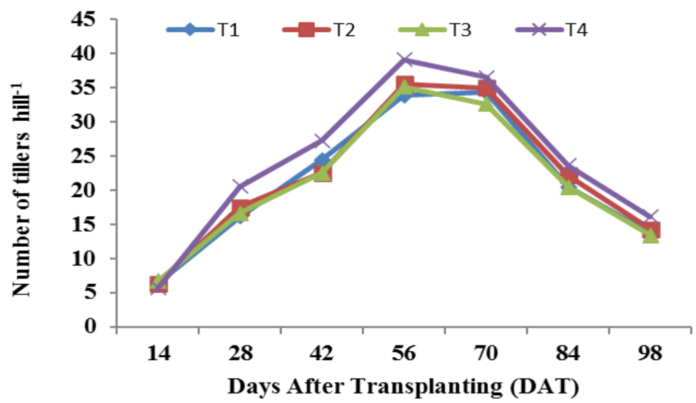

Fig. 2 Influence of chicken manure and chemical fertilizer applications on mean values of number of tillers hill^{-1} of rice

There was no significant difference in number of spikelets panicle^{-1} among the different fertilizer treatment methods. However, the number of spikelets panicle^{-1} ranged from 145.60 to 158.40, with the highest number of spikelets panicle^{-1} occurring in T4 (158.40), followed by T2 (152. 40), T3 (146.15), and the lowest number of spikelets panicle^{-1} was in T1 (145.60) where there was no fertilizer applied. Increases in spikelet panicles^{-1} may be due to the application of chicken manure and chemical fertilizer. The maximum spikelets panicle^{-1} occurred with the addition of organic matter to the soil and this might be due to the availability of macro as well as micro plant nutrients (Siavoshi et al., 2011).

The filled grain percent ranged from 65.61% to 80.10%. The maximum filled grain percentage was shown in T4 (80.10%), followed by T2 (78.10%), T3 (76.48%) and the minimum value occurred in T1 (65.61%). The previous study reported that the combined application of manure and fertilizer significantly increased the number of filled grains panicle^{-1} (Satyanarayana et al., 2002).

The 1000-grain weight ranged from 20.48 g to 22.49 g. The highest 1000-grain weight was in T4 (22.49 g), followed by T2 (21.88 g) and T3 (21.45 g). The lowest 1000-grain weight was in T1 (20.48 g). This result was in conformity to the findings of Yang et al. (2004) who recorded that 1000-grain weight was increased by the application of chemical fertilizer and organic manure.

The highest grain yield (6.87 ton ha^{-1}) was in T4, followed by T2 (6.53 ton ha^{-1}), T3 (6.49 ton ha^{-1}), with the lowest grain yield (6.09 ton ha^{-1}) in T1 treatment where no fertilizer was applied (Fig.3). The T4 treatment (combined application of chicken manure and chemical fertilizer) increased grain yields by up to 12%, over those in the control. The chemical fertilizer application in the T2 treatment increased yields 7% more than in the control. The application of just chicken manure increased yield by 6% compared to the control. To sum up, the application of chicken manure and chemical fertilizer increased the grain yield 6-12% over the control, and also increased the straw yields of rice. It is clear that organic manure in combination with inorganic fertilizers increased the vegetative growth of plants and thereby increased the straw yield of rice (Rahman et al., 2009). The chemical fertilizer offers nutrients which are readily soluble in soil solution and thereby instantly available to plants. Nutrient availability from organic sources is due to microbial action and improved physical condition of soil (Sarker et al., 2004). Several authors have shown that organic amendments play a crucial role in both short-term nutrient supply and long-term build-up of soil quality in flood-irrigated rice crops (Nishikawa et al., 2014). Moreover, organic manures increased soil nutrient availability, improved soil structure and root development and increased soil water availability (Han et al., 2016).

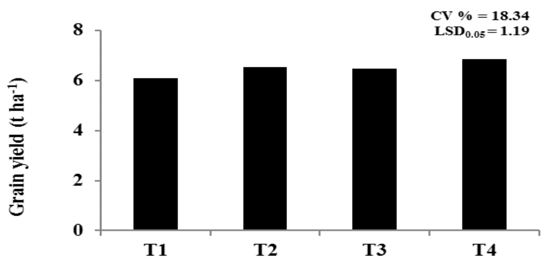

Fig. 3 Influence of chicken manure and chemical fertilizer applications on mean values of grain yield of rice

Table 1 Effect of chicken manure and chemical fertilizer applications on mean values of yield and yield components of rice

Treatments	Number of panicles hill^{-1}	Panicle length (cm)	Number of spikelets panicle^{-1}	Filled grain %	1000-grain weight (g)	Harvest index
T1	10.80	22.78	145.60	65.61	20.48	0.40
T2	12.50	23.37	152.40	78.10	21.88	0.42
T3	11.35	23.22	146.15	76.48	21.45	0.41
T4	12.55	23.92	158.40	80.10	22.49	0.43
$LSD_{0.05}$	3.35	1.56	23.56	18.89	2.30	0.07
Pr>F	ns	ns	ns	ns	ns	ns
CV%	17.94	4.15	9.78	15.73	6.63	10.86

ns = not significant

There was no significant variation in harvest index with different fertilizers application (Table 1). The harvest index ranged from 0.40-0.43. The maximum harvest index occurred in T4 (0.43), followed by T2 (0.42), T3 (0.41) and the minimum value was in T1 (0.40).

CONCLUSION

The application of chicken manure and chemical fertilizer influences the growth, yield and yield components of rice. The largest differences that occur in growth parameters are in plant height, and number of tillers and these occur where chicken manure and chemical fertilizer (T4) are used.

Moreover, the T4 treatment results in the highest yield and yield components. The chicken manure released enough nutrients that resulted in increase in growth and yield of rice and it also improved the soil properties, which in turn resulted in better growth and yield. Additionally, the organic fertilizer can be a better supplement of inorganic fertilizer to produce higher growth and yield. The lowest values for plant growth and yield parameters are recorded in T1 where no fertilizer was applied. Only use of chemical fertilizer is not judicious for producing any crop in agriculture. Therefore, it can be concluded that combined application of organic manure and chemical fertilizer is necessary for crop production as well as maintaining soil fertility in study area.

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