Research article

Effects of Vermicompost and Mineral Water on the Growth Parameters of the KDML 105 Rice Cultivar

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Abstract The purpose of this research aimed to study the effects of vermicompost and mineral water from a wellspring in Ban Haubueng Community Forest, Nampong District, Khon Kaen Province, Thailand on the growth parameters of rice cultivar KDML 105. The rice growth experiments were conducted in a completely randomized design, with four irrigation treatments: irrigation water (T0), irrigation water with vermicompost (T1), mineral water (T2), and mineral water with vermicompost (T3) under greenhouse conditions. The results found that the application of the vermicompost with mineral water gave the highest rice growth parameters; such as plant height, panicles, grains per panicle, and number of tillers per hill, with a significant difference of $p \leq 0.05$. The highest plant height (139.63 cm.) was found in the T1 treatment, and the highest number of tillers per hill and grain weight were found in the T3 treatment at 7.00 and 175.28 grams per plot, respectively; as vermicompost is a rich source of readily available nutrients and contains growth hormones. Although the application of mineral water produced lower plant heights than that of the irrigation water, the tillered rice demonstrated an increased number of tillers per hill and grains per panicle. The results of this experiment revealed that the addition of vermicompost and mineral water had significant positive effects on plant growth parameters of rice. It can conclude that the utilization of mineral water from the wellspring community forest with vermicompost could help farmers to increase rice production.

Keywords vermicompost, mineral water, rice production

INTRODUCTION

Rice is the main staple food in Asia (Ruan et al., 2021), including Thailand, which represents one of the world's largest consumers and top rice exporters (TREA, 2022). The growth of rice depends on the practice of nutrient management in cropping systems (Naivikul, 2007). Chemical fertilizers are applied for rice growth and yield, but in the long term, may damage soil property and increase investment costs. We hypothesized that the application of vermicompost could help improve this issue. Vermicompost is an organic fertilizer, rich in nutrients, used to improve soil. Vermicomposts can significantly influence the growth and productivity of plants (Kale et al., 1992; Kalembasa, 1996; Sinha et al., 2002) due to their micro and macro elements, vitamins, enzymes, and hormones (Makulec, 2002). There are contain nutrients such as nitrates, exchangeable phosphorus, soluble potassium, calcium, and magnesium in plant available forms (Orozco et al., 1996; Edwards, 1998). All of its nutrients are in a readily available form, thereby enhancing their uptake by plants and, in turn, crop yield (Bejbaruha et al., 2013). Several studies have determined that enhancing Nutrient nitrogen, phosphorus, and potassium (NPK) uptake increased rice yields through the application of vermicompost (Srivastava et al., 2014; Bejbaruah et al., 2013). Vermicompost production is not complicated and requires a low investment (Iwai et al., 2011). In this study, we also applied mineral water in the cropping system. Mineral water is a natural water source from the local village forest, which farmers use for both consumption and agriculture. Through analysis, the mineral water's composition was found to contain several nutrients; one of which is silicon, known for its role in alleviating the negative stresses, both biological and physical (Pati et al., 2016), in many plant species (Epstein., 1999). Rice is typically high in silicone and can accumulate up to 10% of its shoot dry weight (Ma et al., 2002).

OBJECTIVE

The purpose of our research was to study the effects of vermicompost and mineral water from the wellspring in the Ban Haubueng Community Forest, Nampong District, Khon Kaen Province, Thailand; on the growth of rice cultivar KDML 105.

METHODOLOGY

Plant Materials and Experimental Design

The seeds of rice cultivar KMDL 105, which are widely planted in Northeast Thailand, were used as plant materials. After soaking in tap water for 24 hours, the seeds were germinated at 30°C for 12 hours and then sown in a basin. The seedlings were then transported to plastic pots 30 cm in height and 30 cm in diameter, and grown under greenhouse conditions. The experiment was conducted in the Faculty of Agriculture, Khon Kean University, Khon Kean Province, Thailand. Six treatments were adopted in the present study, and are described as follows: (T0) irrigation water; (T1) irrigation water with vermicompost; (T2) mineral water; and (T3) mineral water with vermicompost.

The vermicompost used herein was produced by the Vermitechnology for Sustainable Agriculture and Environment, Faculty of Agriculture, Khon Kean University, Khon Kaen, Thailand. The nutrients of vermicompost were analyzed and found various nutrients, as follows: pH 9.05; EC (0.87 dS/m); Organic matter (11.14%); Total nitrogen (7.64 g kg^{-1}); Total phosphorus (11.27 g kg^{-1}); Total potassium (6.18 g kg^{-1}); Magnesium (4.34 g kg^{-1}); and Calcium (64.27 g kg^{-1}). Irrigation water and mineral water were collected from the Ban Haubueng, Nampong District, Khon Kaen Province. The sources of irrigation water come from irrigation canal from Nong Wai Dam as a resources water for agriculture. The mineral water from the wellspring in Ban Haubueng community forest as a naturally occurring water sources. The chemical composition of mineral water was found to contain numerous nutrients, as follows: pH 6.81; EC (0.08 dS/m); NO^{-3} (6.28 mg/L); Cu (0.002 mg/L); Mn (0.008 mg/L); Ni (0.003 mg/L); SiO_2 (17.016 mg/L); and Si (7.954 mg/L).

Measurements of Agronomic Traits

Rice (KDML 105) from each treatment was collected; and the plant height, biomass, number of tillers per hill, fill grains, 100-grain weight, and grain weight were measured. The biomass was measured after being oven-dried at 70°C for 48 hours.

Statistical Analyses

All experimental data were subjected to a one-way analysis of variance (ANOVA) with Statistix 10 software. Differences among means were separated using the least significant difference (LSD) test at a 5% probability level.

RESULTS

Growth Parameters of the rice cultivar KDML 105

The plant height, biomass, number of tillers per hill, fill grains, 100 grains weight, and grain weight of the KDML 105 rice cultivar are presented in Table 1. Plant height, fill grains, and grains per panicle were significantly ($p < 0.05$) increased through the application of the vermicompost (T1, T3). The irrigation water application (T0, T1) presented significantly higher height, fill grains, and grains per panicle than that of the mineral water application (T2, T3). The highest plant height (139.63 cm.) was found in the T1 treatment. However, the mineral water treatments produced significantly ($p < 0.05$) higher amounts of biomass, number of tillers per hill, and grain weight than those found in T0 and T1. The highest number of tillers per hill and grain weight were found in the T3 treatment at 7.00 and 175.28 g. per plot, respectively. Regarding 100 Grain weight, there were no significant differences between treatments. The highest 100 Grain weight (2.49 g.) was found in the T3 treatment.

Table 1 Effects of vermicompost and mineral water on plant height, biomass, number of tillers per hill, fill grains, 100 grain weight, and grain weight of rice cultivar KDML 105

Treatment	Plant height	Biomass (g./plot)	Number of tillers per hill	Fill grains (%)	100 Grain weight (g.)	Grains per panicle	Grain weight (g./plot)
T0 (irrigation water)	132.85 AB	53.03 B	3.75 B	61.81 A	2.42 AB	108.00 A	125.31 C
T1 (irrigation water with VC)	139.63 A	58.04 B	3.88 B	63.18 A	2.35 B	119.44 A	154.01 B
T3 (mineral water)	127.13 B	87.80 A	7.00 A	31.87 B	2.49 A	78.13 B	175.28 A
T4 (mineral water with VC)	130.19 A	86.19 A	7.00 A	38.32 B	2.45 AB	98.81 AB	172.57 A

Treatments with the same letters are not significantly different at ($P<0.05$). VC = Vermicompost.

DISCUSSION

The present study applied vermicompost and mineral water in the growth of rice cultivar KDML 105. Our results of showed that plant height, fill grains, and grains per panicle increased with the application of vermicompost (T1, T3). These results are consistent with the previous studies that demonstrated that the application of vermicompost enhanced the growth and development of crops (Blouin et al., 2019; Ruan et al., 2021; and Suleerak and Suchada, 2014), as a result of the rich source of readily available nutrients and growth hormones (Gandhi et al., 1997; Edwards, 1998) present in the vermicompost. There is further expanded upon the composition of vermicompost as organic fertilizer with multiple mineral elements (Patnaik et al., 2020; Ruan et al., 2021). As previous studies reported, the application of silicon fertilizer alleviated negative stress effects and increased the grain and straw yields, plant height, number of tillers, number of panicles, and 1000-grain weight of rice (Ma and Takahashi, 2002; Pati et al., 2016; Cuong et al., 2017). There is research determined that the accumulation of silicon on the cell walls of the epidermal cells of rice leads to enhanced strength and rigidity of the cells, resulting in increased resistance to pests and diseases, lodging, improved light interception, and reduced transpiration (Meena et al., 2014; Sathe et al., 2021). We, therefore, surmised that the application of vermicompost and mineral water might improve the stress resistance of rice; however, more studies should be performed at the physiological level to further support this hypothesis.

CONCLUSION

The growth parameters of rice cultivar KDML 105; including plant height, panicles, grains per panicle, and number of tillers per hill, improved through the application of vermicompost and mineral water. Therefore, the utilization of mineral water from the wellspring community forest with vermicompost is recommended as a viable agronomic practice to assist farmers in increasing rice production. We train to produce their own vermicompost for using with mineral water to produce quality rice.

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