Research article

Efficiency of Vermicompost on Growth and Nutrients Content of Young Rubber Trees (*Hevea brasiliensis*)

KIRIYA SUNGTHONGWISES*
Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand
E-mail: skiriy@kku.ac.th

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Abstract Vermicompost originates from the breakdown of organic matter by earthworms. Its microbial activity is 10 to 20 times higher than in the soil and contains a higher saturation of nutrients than organic materials. Moreover, vermicompost is also believed to contain hormones and enzymes which it acquires during the passage of the organic matter through the earthworm gut. The hormones and enzymes are believed to stimulate plant growth and discourage plant pathogens. The analysis of the ability of vermicompost through their interactions on seedling growth and nutrients content of *Hevea brasiliensis* will enable to decrease the use of chemical fertilizers while increasing crops yield and for sustaining crop production. In this study, the effect of using vermicompost on growth and nutrients content of rubber seedlings has been studied. Four treatments were supplied with ratios of 1) 100 g/plant of 15-15-15, 2) 50 g/plant of 15-15-15 combined with 500 g/plant of vermicompost, 3) 500 g/plant of vermicompost and 4) 100 g/plant of 15-15-15 combined with 500 g/plant of vermicompost. The results showed a significant rise in growth and nutrients content of rubber seedlings by increasing ratio of vermicompost combined with 50 g/plant of 15-15-15. Obviously, rubber seedlings were mostly appeared in the stem dry weight, N and K content in the leaves part and N, P and K content in the stem part after 6 months in vermicompost applying.

Keywords growth, major nutrients, rubber seedling, vermicompost

INTRODUCTION

In Northeast Thailand, natural rubber is mainly produced by smallholder farmers. N, P and K are essential elements for plant growth and development. Additionally, the majority of soils in Northeast Thailand are acid and sandy. Soils have low water holding capacity, low organic matter content, low cation exchange capacity and low availability of nutrients for plant uptake (Bruand et al., 2004). This poor inherent soil fertility decreases further when the soil is cropped. This has resulted in decreasing quality and quantity of crop yields (Leaungvutiviroj et al., 2006). Applications of chemical fertilizers at high levels can degrade soil and water resources in the long term, leading to the loss of ecosystem services and decrease of agriculture sustainability. Latex yield indicates the growing condition and yield potential of rubber tree. Growth and development depends on many factors such as weather, clone planted, location, water and fertilizers. Akpan et al. (2007) reported that soil constitutes the major aspect of the environment that greatly affects the growth and productivity of rubber trees. The use of organic and inorganic fertilizers increases the efficiency use of chemical fertilizers and soil remediation (Rubber Research Institute of Thailand, 1997).

Vermicomposts are products derived from the accelerated biological degradation of organic wastes by earthworms and microorganisms. Its microbial activity is 10 to 20 times higher than in the soil (Chaoui, 2010). Vermicompost contains a higher saturation of nutrients that believed to contain hormones and enzymes which acquires during the passage of the organic matter through the earthworm gut. The hormones and enzymes are believed to stimulate plant growth and discourage plant pathogens (Gajalakshmi and Abbasi, 2004). Hua et al. (2008) found that water and nutrients are the two main factors limiting *Hevea brasiliensis* growth and its latex yield. Akpan et

al., (2007) suggested that fertility status of soil has some influence on rubber latex yield. Especially, acid sandy soils in Northeast Thailand are low levels of soil parent materials. This has resulted in decreasing quality and quantity of crop yields (Leaungvutiviroj et al., 2006). The aim of this research was to investigate the effect of vermicompost on growth and nutrients content of *Hevea brasiliensis*.

MATERIALS AND METHODS

Experimental Treatments

The *Hevea brasiliensis* RRIM 600 field experiments were conducted at Khon Kaen University, Khon Kaen province, Northeast Thailand in 2013. Northeast Thailand is characterized by a tropical climate with an acid sandy soil. Vermicompost produced from cow manure was applied at rates of 500 g/plant (d.w.) to young rubber trees. Chemical fertilizer (15-15-15 kg NPK) was applied at rates of 100 g/plant after a month of sowing date. Four treatments were supplied with ratios of 1) 100 g/plant of 15-15-15, 2) 50 g/plant of 15-15-15 combined with 500 g/plant of vermicompost, 3) 500 g/plant of vermicompost and 4) 100 g/plant of 15-15-15 combined with 500 g/plant of vermicompost (Table 1).

Table 1 Treatments studied at Khon Kaen University, Khon Kaen province, Northeast Thailand in 2013

Treatment	15-15-15 kg NPK	Vermicompost	Plants
Tr1 Control	100 g/plant	-	Young rubber tree (RRIM 600)
Tr2	50 g/plant	500 g/plant	Young rubber tree (RRIM 600)
Tr3	-	500 g/plant	Young rubber tree (RRIM 600)
Tr4	100 g/plant	500 g/plant	Young rubber tree (RRIM 600)

Young Rubber Trees Plantation and Sampling

The *Hevea brasiliensis* RRIM 600 were transferred to cement blocks with 1 plant/block to control the organic and chemical fertilizers applied. The plants were grown under natural raining and field condition. Growth and development were measured at the end of each month for 6 months. Whole plant samples were harvested for assessment of shoot dry weight, number of leaves, plant high, trunk circumference, stem diameter and macronutrients content (N, P and K) in the shoot. All leaves and stems of young rubber trees were placed into paper bags, oven-dried at 80 °C for 3-4 days before the weight of shoots was determined.

Nitrogen (N), Phosphorus (P) and Potassium (K) Measurements and Ash Alkalinity

For each sample of above-ground biomass N content was measured by micro-Kjeldahl with indophenol blue, P content by wet oxidation and spectrophotometry and K content by wet oxidation and flame photometry.

Statistical Analysis

The experiment was conducted in Completely Randomizing Design (CRD) with 4 replications. An analysis of variance was done on data obtained from each parameter in each treatment. All analysis were carried out using Statistical analysis version 8.0. Least significant differences (L.S.D.) were calculated at $p < 0.05$ and Duncan's multiple-range test was used to test significant differences between treatments. Standard deviation was also calculated for the variance.

RESULTS AND DISCUSSION

Growth and Nutrients Uptake of Young Rubber Trees

Acid-weathered soils of the tropics and subtropics are particularly prone to P deficiency. Worldwide, phosphorus is considered as the principal yield-limiting nutrient along with nitrogen (Zahran, 1999). Phosphorus deficiency is a primary constraint to plant growth in many terrestrial ecosystems (Bonser et al., 1996). Under low soil pH, phosphate is adsorbed on clay minerals and other factors such as low soil moisture affect the availability of phosphorus (Karmarkar et al., 1997; Roychaudhary et al., 2003). P deficiency has two main causes: (i) the low content in total P of some soils poor in organic matter or highly weathered, and (ii) the complexation of P with cations such as Ca, Al or Fe, which makes P unavailable to the plants, as in acid soils. Nitrogen (N) elements is a key component of amino acids, proteins, chlorophyll, enzymes and it's also involved with the metabolic effect. Phosphorus (P) affects the rate of growth of the circumference and latex during the beginning of rubber growth (Punnoose et al, 1976). Potassium (K) is a critical component of enzymes that aid in the protein synthesis, carbohydrate and sugar delivers, acid – base control, the opening - closing of the stomata. Moreover, allows all parts of the plant and root system are strong and resistant to disease and insects. However, excessive amounts of K fertilizer will decline Mg and Ca of rubber trees and P fertilizers are not always available or affordable to farmers in the tropics. The experimental strategy employed during this research enabled to determine the possibility of vermicompost applying for 6 months on growth and nutrients uptake of young rubber trees cv. RRIM600. The results founded that no statistical difference was significantly greater for the growth of leaves and stems of young rubber (Fig. 1). As the suitable chemical formula fertilizer for small rubber trees is 20-8-20 with the rate of 410 g/plant (Rubber Research Institute, 1997) which its far from our practices. However, the application of 15-15-15 by 50 g/plant with 500 g/plant of vermicompost statistically significant difference in K accumulation in the trunk (Fig. 4) and their rates of application likely tends to produce vegetative growth, N and P accumulation of young rubber trees (Figs. 2 and 3). This probably related to phosphorus element in the vermicompost and also other important nutrients are found such as calcium, magnesium and potassium nitrate. However, not only macronutrients those are vital to the growth of rubber trees. Micronutrients including manganese (Mn), zinc (Zn), iron (Fe), copper (Cu), boron (B) and the molybdenum (Mo) are also necessary which are typically found in humus. Future research the increasing in volume of vermicompost application with a suitable chemical formula fertilizer may enable to promote the growth and nutrients uptake of young rubber trees cv. RRIM600.

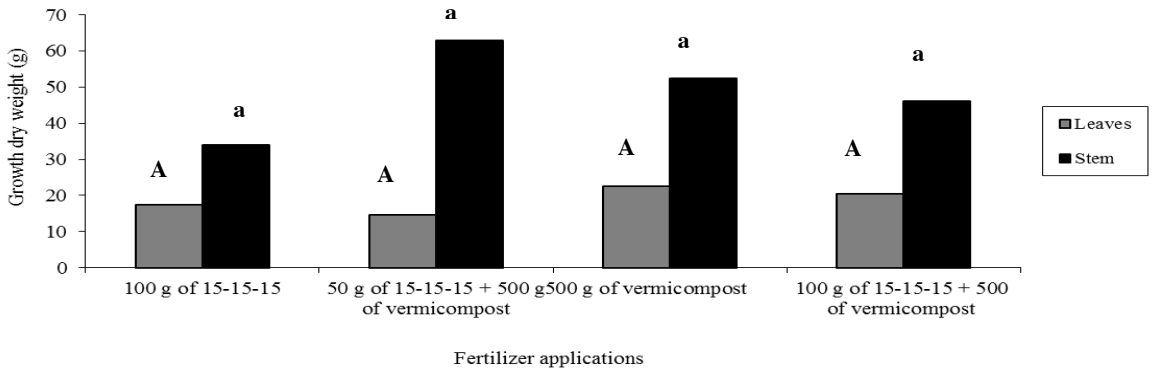

Fig. 1 Vegetative growth of rubber seedling cv. RRIM600 after 6 months

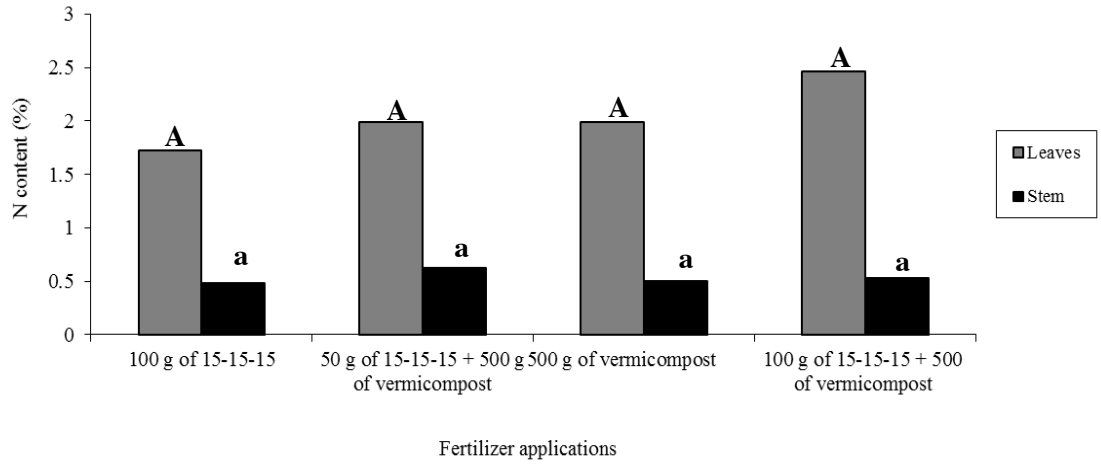

Fig. 2 N content of rubber seedling cv. RRIM600 after 6 months

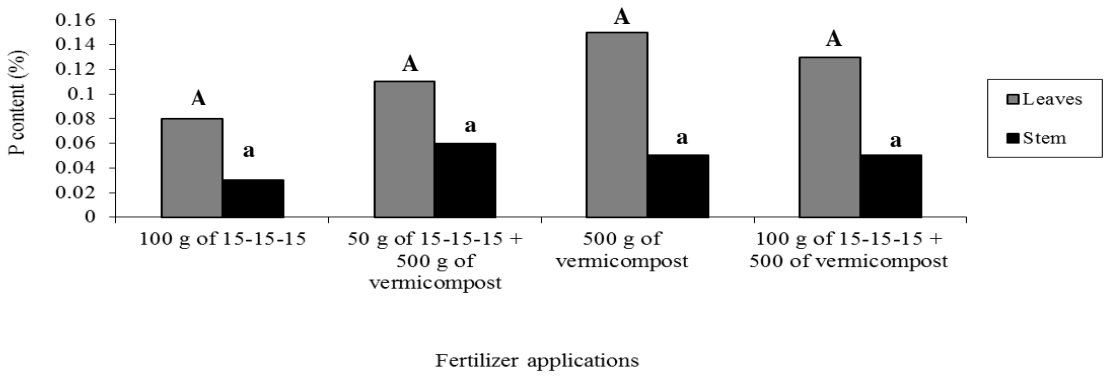

Fig. 3 P content of rubber seedling cv. RRIM600 after 6 months

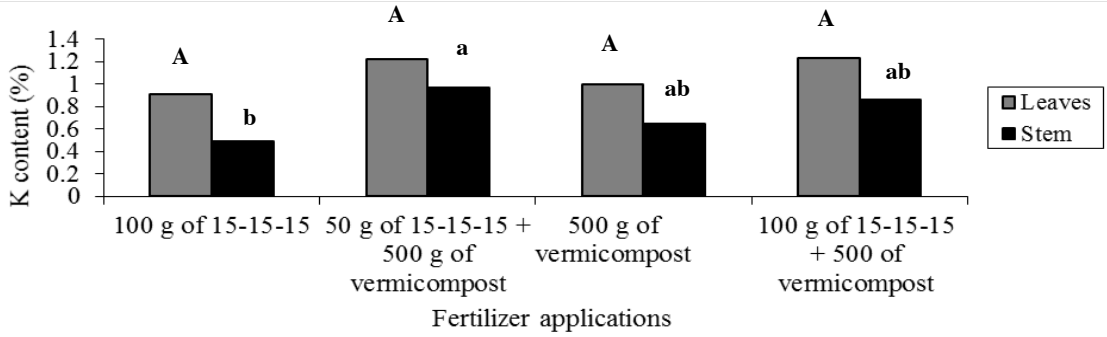

Fig. 4 K content of rubber seedling cv. RRIM600 after 6 months

CONCLUSION

The application of vermicompost with chemical fertilizer with the young rubber trees cv. RRIM 600 found that 50 g/plant of 15-15-15 combined with 500 g/plant of vermicompost significantly increase in K content and tend to promote the growth and N, P content after 6 months. While the

application of 100 g/plant of 15-15-15 combined with 500 g/plant of vermicompost and 500 g/plant of vermicompost are not significantly increase in leaves growth and N, P and K content. This work provides a first step towards by using vermicompost as bio-fertilizers for improving rubber growth and nutrient uptake, soil fertility and sustainable crop production in nutrient poor systems.

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