Performance of *Hevea brasiliensis* on Haplic Acrisol Soil as Affected by Different Source of Fertilizer

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Abstract

Rubber has been planted widely in South East Asia since more than a century ago. Rubber usage has been discovered and developed for various usages. This situation induces demand for natural rubber to increase steadily . Nitrogenous fertilizer is very important in growing stage. This study will provide details about effect of fertilizer, nitrogenous on Haplic Acrisol soil which has been classified as first class in soil suitability for rubber tree. Through this study, it was found that urea performs equally as well when compared to ammonium sulphate at the equivalent of 10% N. However, in terms of cost per unit nitrogen, urea is very much cheaper; the cost of urea is around USD350-500 per ton, compared to the cost of ammonium sulphate which is USD 5670-6190 per ton. The dosage of urea used should be controlled because it can cause adverse effects on the plant if over applied. The leaves of plant will scorch, the soil will crust, and the plants will be vulnerable to infection. The study provides information for further improvement in rubber nursery management.

Keywords: *Hevea brasiliensis*, rubber, Fertilizer, Haplic Acrisol, Urea, Agrenas, Ammonium Sulphate

1. Introduction

Rubber tree (*Hevea brasiliensis*) has been discovered since the fifteenth century, when Christopher Columbus discovered the Americas. Since then, several usage of rubber has been discovered from time to time (Noordin, 1993). Rubber tree is well known for its latex production, and now as timber. Rubberwood have been used for furniture making (Malaysia Rubber Board, 2009). Suitable planting area now decreased and to overcome this problem, planting of rubber in other region is necessary (Noordin, 2010). In the case of rubber, clones refer to rubber plants produced from the selection and breeding process, and which have been field-tested. There are several selection criteria in rubber breeding. These include vigor, resistance to diseases, resistance to wind, fewer and higher branches, bark thickness and yield (Malaysia Rubber Board, 2009; Noordin, 2008). The clones are produced to improve the yield of the rubber tree. In recent times, yield is not only the latex, but also the timber from the tree which has a high demand as well.

To satisfy the demand for latex and timber, the Malaysian Rubber Board (MRB) has conducted research to produce rubber trees which can give high yields of latex and timber; and the result is the RRIM 2000 series of clones. All these clones also have a high growth rate and can be tapped to produce latex yield within a shorter period of time (Malaysia Rubber Board, 2009; Malaysia Rubber Board, 2007). A fertilizer can be defined as a mined, refined or manufactured product containing one or more essential plant nutrients in available or potentially available forms (Roy et *al.*, 2006). Nitrogen is absolutely essential to plant growth. Plants grown in soil with sufficient amounts of available N make for vigorous, rapid growth with leaves having a healthy deep green color (Martin et *al.*, 2006). Nitrogen deficiency symptoms in rubber are seldom reported in Malaysia; this is probably due to the widespread use of nitrogenous fertilizers, and also to the general use of leguminous cover crops when replanting rubber (Shorrocks, 1964).

Plants suffering from N deficiency mature earlier and the vegetative growth stage is often shortened (Mengel and Kirkby, 1987). Urea is classified chemically as an organic compound and contains 46 % N by weight. It can be used as a nitrogenous fertilizer which can be applied as a solid or as a solution (PETRONAS, 1988). Ammonium sulphate (21%N), a white crystalline chemical synthesized from ammonia and sulphuric acid, is largely used for rubber grown on inland soils of Malaysia (Tajuddin, 1979). The fertilizer consumption in the country has increased tremendously and is likely to continue to do so, while at the same time, the costs of fertilizers are ever increasing. There is an urgent need to know the types of fertilizers, their characteristics and quality suitable for rubber. Fertilizers are important especially in the nursery stage. In establishing rubber nurseries the focus now will be on the latest clones with the right fertilizers for the growth of the scions. This is to ensure maximization of profits. A local company, PETRONAS has launched its own brand of urea fertilizer, Agrenas, which is expected to give higher yield, and to support the growth of Malaysia's agriculture sector.

According to USDA soil taxonomy, Rengam series has been classified as clayey, Typic Paleudult. In the FAO/UNESCO Legend, this soil has been classified as Haplic Acrisol (Department of Agriculture, 2008). Rengam series soil is coarse sandy clay with yellowish brown to brownish yellow. The structure of this soil series is fine to moderate and medium sub-angular blocky. This soil has been classified as the first class soil for rubber planting in term of soil-crop suitability (Malaysia Rubber Board, 2009; Noordin, 1981).

2 Materials and Methods

2.1 Plant materials and experimental treatments

The study was carried out in the nursery. Four treatments with four replicates which contain three plants for each treatment were carried out using the completely randomized design (CRD): scions fertilized with the nitrogenous fertilizer Agrenas 1 (21.74 g/plant, equivalent to 10.87 kg/ha), Agrenas 2 (43.48 g/plant = 21.74 kg/ha), ammonium sulphate (47.62 g/plant = 23.81 kg/ha), and unfertilized scions. Agrenas is a commercial brand of urea. The unfertilized scion was used as the control in this study. The respective treatments had the equivalent of 10% N (T1), 20% N (T2), and 10%N (T3) and zero N (T4). The rates were chosen according to current practice, as recommended by the Rubber Industry Smallholders Development Authority (RISDA). The scions used were the RRIM 2000 series clone at the six-month stage in 15cm x 33cm polythene bag filled with Rengam series soil as the medium. Fertilizer application was done every six weeks at the same rates. The fertilizer was incorporated into the soil around the plant to prevent loss of nitrogen through volatilization.

2.2 Data Collection

The study duration was 24 weeks, and data were collected at the end of the study. Plant height was measured from the soil surface to the shoot tip. The girth was measured at 10cm from the soil. Leaf sampling was done according to foliar sampling method adopted by the Malaysian Rubber Board (MRB). Four basal leaves from the first sub-terminal whorl were collected as a leaf sample (Rubber Research Institute of Malaysia, 1990). The sampled leaves were cut from stems and placed in the forced draft oven at 60ºC for 48 hours. After that, the weights were determined using a weighing machine. The leaf samples were used for (N) analysis by an atomic absorption spectrophotometer (AAS).

2.3 Experimental design and data analysis

The study was conducted in a completely randomized design with four replications. Analysis of Variance (ANOVA) on data obtained was performed using Statistical Analysis System (SAS 9.1, SAS Institute, Inc. Cary NC. USA). Least Significant Different (LSD) test at $p<0.05$ was employed for mean comparison.

3 Results and Discussions

The results show that urea (Agrenas) performed equally well as ammonium sulphate in both efficiency and growth. This was shown by treatment T1 (urea, 10%N) which gave an almost similar response to ammonium sulphate (T3) as reflected by leaf dry weight, leaf N content, height and girth increment measurements. ANOVA for height and girth at 24 weeks and the LSD Test showed that at the probability level of ($P<0.05$) T2 had a lower height and girth compared to the other treatments (Figure 1 and Figure 2). This may have been because the dosage in T2 was too high for rubber plants at this stage of growth. Most of leaves of the plants in T2 were scorched and some had abscised from the plant. Plants recovering from defoliation showed bursts in new vegetative buds. Nutrients, especially N, were utilized to produce new leaves. Consequently, the plants from T2 were lower in girth and height.

Figure 1: Comparison of Total Plant Height due to Different Fertilizer Treatments after 24 Weeks

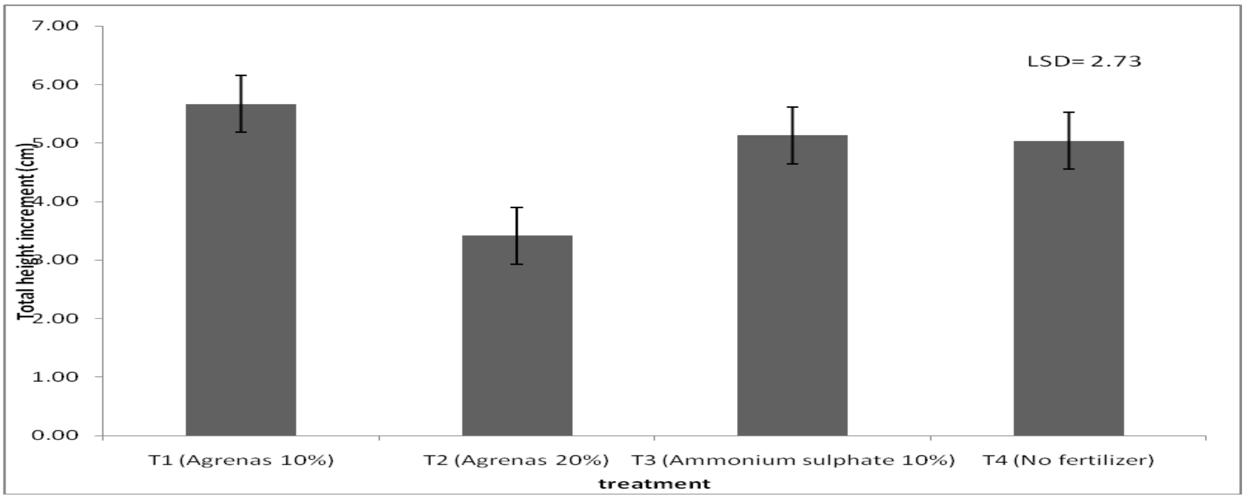


Figure 2: Comparison of Total Girth Circumference due to Different Fertilizer Treatments after 24 Weeks

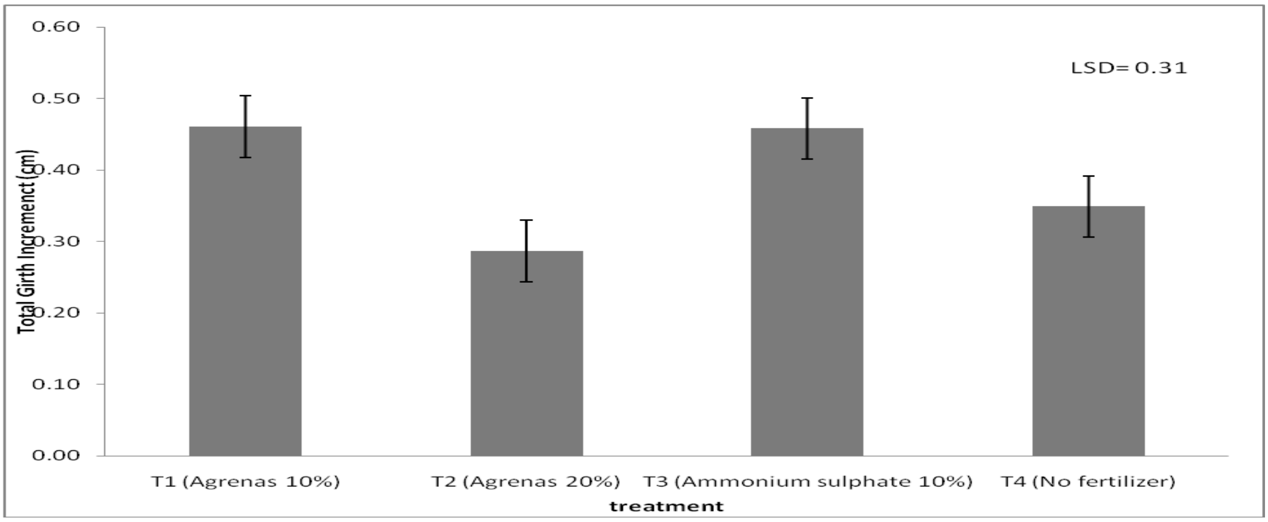
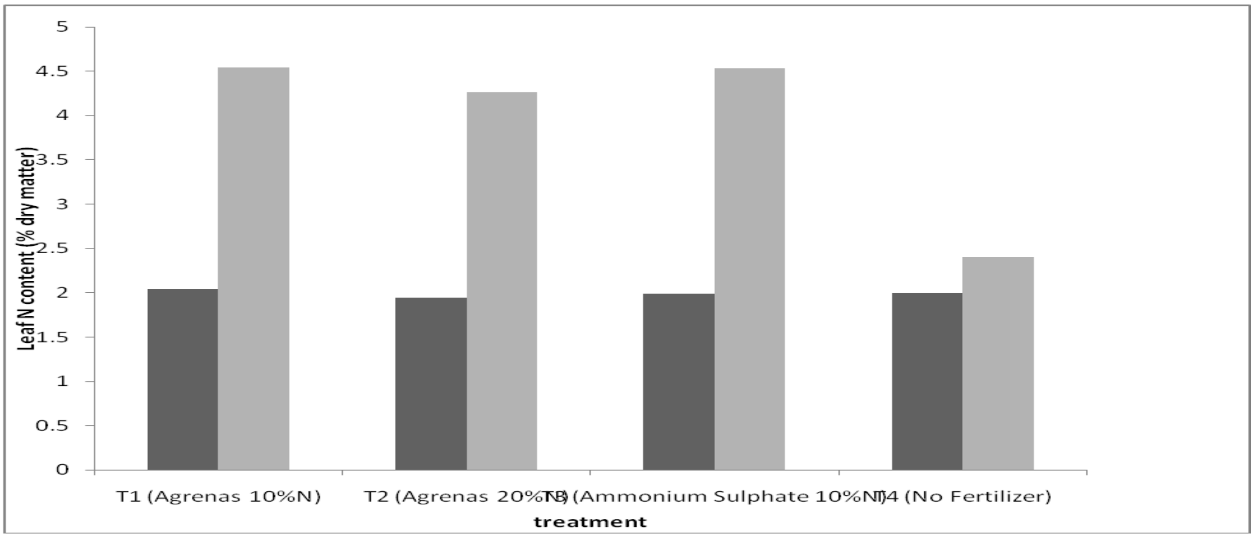


Table 1: Dry weight of rubber plant as affected different fertilizer treatment

Treatment	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
Agrenas 10% (T1)	4.53a	22.13a	30.40b
Agrenas 20% (T2)	1.96b	14.95a	22.89c
Ammonium Sulphate(T3)	5.26a	21.38a	34.41a
No Fertilizer (T4)	1.80b	21.00a	21.98c
$LSD_{0.05}$	1.26	10.18	3.24

The treatment with ammonium sulphate (T3) produced the highest mean leaf dry weight at 5.26g, followed by urea at 10%N (T1) with 4.53g; urea at 20%N (T2) with 1.96g and the lastly the control (T4) with 1.80g (Table 1). There was no significant difference between T3 and T1 and between T2 and T4 according to the LSD test. For leaf N content (Figure 3), T1 (4.54%) and T3 (4.54%) were not significantly different, but significant from the other treatments, T2 (4.26%) and T4 (2.4%). The leaf N content in T2 was less than T1 and T3. Over-fertilization may have harmed the plant roots, thus interfering with nutrient (including N) uptake in T2.

Figure 3: Comparison of Leaf Nitrogen Content due to Different Fertilizer Treatments. ■ initial; ■ after 24 weeks.



The observed scorching effect mentioned above due to excessive application of fertilizer in T2 resulted in the leaves of the plants turning yellow and dying. In the first week after applying fertilizer, all the plants in treatment T2 showed leaf scorch. Too much nitrogen had desiccated or damaged the roots, producing these foliar symptoms in *Hevea brasiliensis*. Consequently the plants were more vulnerable to fungal and bacterial infections (Sara, 2008; Diane et *al.*, 2002). The soil in the polythene bag to which a high dosage of urea had been applied also showed evidence of crusting. This soil crusting resulted in impeding the percolation of water through the soil, and water was therefore not readily available to the roots; hence, plant growth was affected.

Other studies on over dosage of fertilizer in other crops indicate that a crusting layer developed from excess fertilizer even when the fertilizer was incorporated into the soil during application (North Carolina University, 2010; Mary, 2009; Arizona University, 1998).

4 Conclusion

The findings indicate that urea (Agrenas) was as good as ammonium sulphate for the parameters leaf dry weight, leaf nitrogen content, height and girth increment at the same level of N application. The cost of urea (USD350-500 per ton) (Alibaba, 2010) being very much cheaper compared to ammonium sulphate (USD 5670-6190 per ton) (Alibaba, 2010), hence the use of urea (Agrenas) is more economical in providing nitrogen compared to ammonium sulphate. From the results, it can be concluded that the best fertilizer treatment for raising RRIM 2000 series rubber scions was applying urea or ammonium sulphate at a rate equivalent to 10% N. This study suggests that in future urea can be used as a nitrogen source for young rubber instead of ammonium sulphate.

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