



UNIVERSITI PUTRA MALAYSIA

***EFFECTS OF COW MANURE ON
THE GROWTH OF BARU CINA
(*Artemisia vulgaris* L.)***

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**EFFECTS OF COW MANURE ON THE GROWTH OF BARU CINA
(*Artemisia vulgaris* L.)**

By

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ABSTRACT

Herbal plants have their own values for medicinal, aromatic or savory qualities. Major pharmaceutical companies are currently conducting extensive research on plant materials gathered from rain forests and other places for their potential medicinal values. As time goes by, because of the over exploitation of this natural resource of medicinal plants in the forest, it is become scarce and may face extinction. This research was conducted to evaluate the effects of the different levels of cow manure on the growth of Baru Cina (*Artemisia vulgaris*). Ten different levels of cow manure were applied on Baru Cina (*Artemisia vulgaris*) seedlings. Every experimental unit has five replicates and arranged randomly using Completely Randomized Design (CRD). The parameters measured are plant biomass, plant height, and nutrient content (N, P, K) in the foliage and soil before and after planting. Laboratory analysis using dry ashing method was done to determine P and K in plant samples and double acid method was used for K in the soil. Kjeldhal and Aqua Regia method were also used to determine for N in the leaves and soil samples and P in the soil samples. The results obtained showed that T3 was the highest for plant height with a mean of 48.73 cm. Biomass of leaves were not significantly different between treatments. T7 has the highest total biomass with value of 0.83g. The highest level of N uptake by the leaves was 0.14% in T7. The nutrient concentration in the soil before planting was higher than that after harvest.

ABSTRAK

Tanaman herba mempunyai nilai yang tersendiri meliputi dari segi perubatan, aromatic dan juga keunikan dalamannya. Kebanyakan syarikat melakukan kajian yang mendalam terhadap tanaman herba kerana ia amat berpotensi dan mengelakkan daripada berlakunya kepupusan terhadap tanaman herba. Kajian ini dijalankan untuk menilai kesan tahap perbezaan baja tahi lembu ke atas pertumbuhan dan pengambilan nutrien pada Buku Cina (*Artemisia vulgaris*). Sepuluh tahap perbezaan baja tahi lembu telah diaplikasikan pada anak pokok Buku Cina (*Artemisia vulgaris*). Setiap unit eksperimen dengan lima replikasi disusun secara rawak mengikut rawak lengkap (CRD). Parameter bagi kajian ini termasuklah biojisim pokok, ketinggian pokok, kandungan nutrien pada sampel daun serta sampel tanah selepas dan sebelum penanaman. Analisis makmal menggunakan kaedah 'Dry Ashing' untuk menentukan kandungan nutrient bagi elemen P dan K pada sampel daun dan kaedah 'Double Acid' telah digunakan untuk menentukan elemen K pada sampel tanah. Kaedah Kjeldhal dan Aqua regia juga telah digunakan untuk menentukan elemen N bagi sampel daun dan tanah serta elemen P bagi sampel tanah. Keputusan kajian ini menunjukkan T3 adalah ketinggian pokok yang paling tinggi dengan purata 48.73 cm. Biojisim bagi daun tiada perbezaan ketara antara rawatan. T7 adalah biojisim daun yang paling tinggi dengan purata 0.82g. Pengambilan nutrien yang paling tinggi adalah dari T7 dengan purata 0.14%. Kepekatan nutrien pada tanah sebelum penanaman adalah tinggi berbanding kepekatan nutrien pada tanah selepas tuai.

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APPROVAL

I certify that this research project report entitled “**Effects of Cow Manure on The Growth of Baru Cina (*Artemisia vulgaris L.*)**” has been examined and approved as a partial fulfillment of the requirement for the degree of Bachelor of Science Bioindustry in the Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus.

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LIST OF ABBREVIATIONS

AAS – Atomic Absorption Spectrophotometer

Ca – Calcium

Cu – Copper

C - Carbon

DMRT- Duncan's Multiple Range Test

HCl – Hydrochloric acid

HNO₃ – Nitric acid

H₂SO₄ – Sulphuric acid

K – Potassium

KCl – Potassium chloride

Mg – Magnesium

ml – millilitre(s)

N – Nitrogen

Na – Sodium

O - Oxygen

P – Phosphorus

ppm – Parts per million

SAS – Statistical Analysis System

S - Sulphur

T – Treatment

USDA- United States Department of Agriculture

CHAPTER 1

INTRODUCTION

1.1 Background

In the last few decades, herbal medicine is gaining worldwide acceptance as a complementary or alternative medicine. With the increase in the popularity of plants as a source of alternative medicine, more herbal plants are now available in various forms in the market. There has been a rapid development in the herbal industry utilizing locally available plants, either wild or introduced. Therefore, an accurate identification is crucial before chemists and pharmacognosists can search for new chemical substances from these plants. According to the latest report, there are about 1,200 species of plants in this country that have potential pharmaceutical values. (Hussin *et al.*, 2006).

The comparative advantage of the herbal industry in Malaysia is based mainly on its diverse composition of flora. Some of these plants are known to have active ingredients and are being demanded increasingly by local as well as international markets especially for food, health and therapeutic values. Indeed, Malaysia has a competitive advantage to develop its own herbal/traditional medicines and pharmaceutical industry because of its rich bio-resources endowment. Several research institutions have undertaken initiatives to collect, identify and promote the benefits of some well-known herbal plants such as *Eurycoma longifolia* (Tongkat Ali), *Labisia pumila* (Kacip Fatimah), *Centella asiatica* (Pegaga), *Morinda citrifolia* (Mengkudu). amongst others. Currently, little is known on the active ingredients and

benefits present in many of the herbal plants found vastly in the country. (Hussin *et al.*, 2006).

According to In Sarawak , herbal endeavour is presently concentrating on a traditional and small scale basis particularly to meet local demand. Herbal activity mainly comprised of collection of plants from the wild by the indigenous people and sold at wet market and retailing by the established pharmaceutical shops and medical hall. Thus, at the broader perspective, pertinent issues on herbal industry include lack of research and development initiatives, manufacturing facilities, skilled manpower and expertise, inadequate infrastructure and marketing network, inadequate investment strategies and lacking of public awareness. These issues need to be addressed in order for the industry to thrive competitively within the domestic and international markets. One of the important research that has been neglected is the agronomic aspects of growing the herbal plants. This include the nutrition and fertilization aspect of which this present study attempts to do.

1.1 Problem Statement

Herbs have their own values for their medicinal, aromatic or savory qualities. Major pharmaceutical companies are currently conducting extensive research on plant materials gathered from rain forests and other places for their potential medicinal value. As time goes by, because of the over exploitation of this natural resources of medicinal plants in forest, it is become scarce and will face extinction. Therefore, to avoid the valuable herbs from extinction, it is necessary to cultivate them

1.3 Objectives

This study was conducted under controlled conditions (net house) in Universiti Putra Malaysia Bintulu Campus with the main objective to evaluate the effects of different levels of cow manure on the growth performance of *Artemisia vulgaris*.



CHAPTER 2

LITERATURE REVIEW

2.1 Medicinal plants

2.1.1 Industry and potential

The use of medicinal plants in human health is recognized throughout the world. In fact, the practice of using medicinal plants as medicine has long been the way of life, especially in rural areas. With the current research and technology, some medicinal plants which were used in small quantities, are now being produced commercially. Plants have played, and will continue to play, an important role in the research and development of pharmaceuticals. Dumville (1988) stated that one in four prescriptions dispensed from community pharmacies in the United States has been found to contain active ingredients derived from higher plants.

Plant-derived compounds contribute to the research and manufacturing of pharmaceuticals in three ways mainly as a continuous supply of raw materials, as chemical building blocks for creating more complex compounds and also as a models of new types of pharmacological action that can act as a template for synthesis of novel analogues (Janick and Simon, 1990).

2.2 *Artemisia vulgaris* L.

Artemisia vulgaris (Mugwort or Baru Cina) is one of several species in the genus *Artemisia*. It is native to temperate Europe, Asia and northern Africa, but is also present in North America where it is an invasive weed. It is a very common plant

growing on nitrogenous soils and weedy and uncultivated areas, such as waste places and roadsides.

2.2.1 Botanical Description

It is a tall herbaceous perennial plant growing 1-2 m (rarely 2.5 m) tall, with a woody root. The leaves are 5-20 cm long, dark green, pinnate, with dense white tomentose hairs on the underside. The erect stem often has a red-purplish tinge. The rather small flowers (5 mm long) are radially symmetrical with many yellow or dark red petals. The narrow and numerous capitula (flower heads) spread out in racemose panicles. (M. Daniel, 2006)

2.2.2 Medicinal properties

The plant contains ethereal oils (such as cineole, or wormwood oil, and thujone), flavonoids, triterpenes, and coumarin derivatives. It was also used as an anthelmintic, so it is sometimes confused with wormwood (*Artemisia absinthium*). The plant, called *nagadamni* in Sanskrit, is used in Ayurveda for cardiac complaints as well as feelings of unease, unwellness and general malaise. The active chemical thujone, and the plant's hallucinogenic properties were probably the reasons why these feelings went away. (Joseph *et al.*, 2005)

Artemisia vulgaris is used in the practice of traditional Chinese medicine in a pulverized and aged form called moxa from which we derive the English word 'moxo'. The British RCT yielded results that indicate that moxibustion of mugwort was indeed effective at increasing the cephalic positioning of fetuses who were in a

breech position before the intervention. Since it also causes uterine contractions, it has been used to cause abortion. (M. Daniel, 2006)

2.3 Plant Nutrition

2.3.1 Organic Fertilizers

Organic fertilizers are natural materials of either plant or animal origin, including livestock manure, green manures, crop residues, household waste, compost, and woodland litter. On the other hand, inorganic (or mineral) fertilizers are fertilizers mined from mineral deposits with little processing (e.g., lime, potash, or phosphate rock), or industrially manufactured through chemical processes (e.g., urea) (Jones, 2007).

Organic fertilizers depend on soil organisms to break them down to release nutrients. Therefore, they are effective only when soil is moist and warm enough for the microorganisms to be active. Nutrient release by microbial activity, in general, occurs over a fairly long time period. One potential drawback is that the organic fertilizer may not release enough of their principal nutrient when the plant needs it for growth.

According to Gupta (2007), cow manure is an excellent fertilizer for the soil, providing such nutrients as nitrogen, phosphorus, and potassium. Cow manure application can also benefit the soil's water holding capacity and tilt. When using this manure, however, one should follow good management practices in order to avoid hazards to the crop and the environment.

Cow manures have been used effectively as fertilizers for centuries. Cow manure has long been recognized as perhaps the most desirable of these natural fertilizers because of its high nitrogen content. In addition, cow manures supply other essential plant nutrients and serve as a soil amendment by adding organic matter. (Sloan, D.R. *et al.*, 2003)

2.3.2 Inorganic fertilizers

Inorganic fertilizers are fertilizers that contain in every granule a number of elements that are essential for plants. Synthesized materials are also called artificial and may be described as straight, where the product predominantly contains the three primary ingredients of nitrogen (N), phosphorus (P) and potassium (K), which are known as N-P-K fertilizers when elements are mixed intentionally. They are named or labeled according to the content of these three elements, which are macronutrients.

Commercial fertilizer, especially nitrogen, is easily washed below the level of the plant's root system through the leaching of rain or irrigation. An application which is too heavy or too close to the roots of the plants may cause "burning" (actually a process of desiccation by the chemical salts in the fertilizer). As well, overly heavy applications of commercial fertilizers can build up toxic concentrations of salts in the soil, thus creating chemical imbalances. If organic materials are readily available and cheap, the expense of the commercial fertilizer should also be considered.

2.4 Organic farming

Sharma (2004) stated organic farming in dry lands can start with medicinal plants because the forest resource of medicinal plants is decreasing but demand is increasing thus cultivation is the only solution to fill this gap. Furthermore, medicinal plants are for the curing of disease and any residue of pesticide can convert it into poison. Hence medicinal plants should only be cultivated in organic farming. On the other hand, the use of high dose of inputs like fertilizers, and irrigation may change the composition and quality of medicinal plants. Growing near to natural conditions is the best way to maintain the quality which is possible in organic farming.

In 1980, USDA released a landmark report on organic farming. The report defined organic farming as a production system, which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent feasible, organic farming systems rely upon crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation, mineral-bearing rocks and aspects of biological pests control to maintain soil productivity, to supply plant nutrients and to control insects, weeds, and other pests (Prajapati *et al.*, 2004).

2.5 Evaluation of growth performance

2.5.1 Soil and plant analysis

Soil testing encompasses a series of steps from field sampling to laboratory analysis. A soil test begins with field sampling and preparation prior to laboratory analysis. Once the soil has been prepared for laboratory analysis, various tests are performed to determine those characteristics needed to evaluate the fertility status of the soil and to make a lime and fertilizer recommendation (Brady, 2002).

On the other hand, plant analysis, sometimes referred to as leaf analysis, is the technique for determining the elemental content of tissue of a particular plant part. Plant analysis can play a major role when diagnosing mineral nutrition problems, whether for research purposes or for solving practical field problems. Normally, a plant analysis refers to a laboratory analysis of collected plant tissue. Jones (2001) stated that plant analysis is carried out as a series of steps which are sampling, sample preparation, laboratory analysis and an interpretation and recommendation.

Apart from that, soil testing and leaf diagnosis are complementary. Soil testing has the advantage of being able to measure the level of nutrients available in the soil, and the extent to which these will be available to the crop during the growing period.

Leaf diagnosis shows the nutrient status of the plant at the particular time of sampling, often in time for any deficiencies to be remedied while the crop is still growing to maturity. However, leaf diagnosis alone may not give an accurate picture of fertilizer requirements.

Soil nutrient levels are only one of many factors which determine a crop's nutritional status. There are other important factors which influence nutrient uptake by plants, such as temperature, and various stresses such as water deficiency or water surplus. Furthermore, the presence or absence of one nutrient element may affect the uptake of another. Because of the complexity of factors affecting the results, leaf analysis has to be integrated with soil analysis (Jones, 2001).

A previous study by Migliaccio *et al.* (2007), showed that visual inspection of plant, tissue nutrient concentrations and soil analysis must be combined together in order to evaluate actual plant growth rate.

2.5.2 Essential nutrient for plant growth

Plants, like all other living things, need food for their growth and development. K, Ca, Mg, Fe, Cu and Zn using the Atomic Absorption Spectrophotometry (AAS). Plants require 16 essential elements. Carbon, hydrogen, and oxygen are derived from the atmosphere and soil water. The remaining 13 essential elements (nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, zinc, manganese, copper, boron, molybdenum, and chlorine) are supplied either from soil minerals and soil organic matter or by organic or inorganic fertilizers.

According to J. A. Silva (2000), for plants to utilize these nutrients efficiently, light, heat, and water must be adequately supplied. Cultural practices and control of diseases and insects also play important roles in crop production. Each type of plant is unique and has an optimum nutrient range as well as a minimum requirement level. Below this minimum level, plants start to show nutrient deficiency symptoms. Excessive nutrient uptake can also cause poor growth because of toxicity.

2.5.2.1 Nitrogen (N)

Nitrogen is available to plants as nitrate (NO_3^-) and ammonium (NH_4^+) ions. Nitrogen is biologically combined with C, H, O, and S to create amino acids, which are the building blocks of proteins. Amino acids are used in forming protoplasm, the site for cell division and thus for plant growth and development. Since all plant enzymes are made of proteins. Nitrogen is needed for all of the enzymatic reactions in a plant. Nitrogen is a major part of the chlorophyll molecule and is therefore necessary for photosynthesis. Nitrogen is a necessary component of several vitamins. Nitrogen improves the quality and quantity of dry matter in leafy vegetables and protein in grain crops. Nitrogen also help vegetative growth and it may delay maturity of fruits and seeds.

There are some symptoms of nitrogen deficiencies such as stunted growth may occur because of reduction in cell division. Pale green to light yellow color (chlorosis) appearing first on older leaves, usually starting at the tips. Depending on the severity of deficiency, the chlorosis could result in the death and/or dropping of the older leaves. This is caused by the translocation of N from the older to the younger tissues. Reduced N lowers the protein content of seeds and vegetative parts. In severe cases, flowering is greatly reduced. N deficiency causes early maturity in some crops, which results in a significant reduction in yield and quality.

2.5.2.2 Phosphorus (P)

Phosphorus is available to plants as orthophosphate ions (HPO_4^{2-} , H_2PO_4^-). Phosphorus functioned in photosynthesis and respiration as it plays a major role in

energy storage and transfer as ADP and ATP (adenosine di-and triphosphate) and DPN and TPN (di-and triphosphopyridine nucleotide). Phosphorus is part of the RNA and DNA structures, which are the major components of genetic information. Seeds have the highest concentration of P in a mature plant, and P is required in large quantities in young cells, such as shoots and root tips, where metabolism is high and cell division is rapid. Phosphorus aids in root development, flower initiation, and seed and fruit development. Phosphorus has been shown to reduce disease incidence in some plants and has been found to improve the quality of certain crops.

There are some symptoms of nitrogen deficiencies as phosphorus is needed in large quantities during the early stages of cell division, the initial overall symptom is slow, weak, and stunted growth. Phosphorus is relatively mobile in plants and can be transferred to sites of new growth, causing symptoms of dark to blue-green coloration to appear on older leaves of some plants. Under severe deficiency, purpling of leaves and stems may appear. Lack of P can cause delayed maturity and poor seed and fruit development.

2.5.2.3 Potassium (K)

Potassium is available to plants as the ion K^+ . Unlike N and P, potassium does not form any vital organic compounds in the plant. However, the presence of potassium is vital for plant growth because potassium is known to be an enzyme activator that promotes metabolism. Potassium assists in regulating the plant's use of water by controlling the opening and closing of leaf stomates, where water is released to cool the plant. In photosynthesis, potassium has the role of maintaining the balance of electrical charges at the site of ATP production. Potassium promotes the translocation of photosynthates (sugars) for plant growth or storage in fruits or roots.

Through its role assisting ATP production, potassium is involved in protein synthesis. According to J. A. Silva (2000), potassium has been shown to improve disease resistance in plants, improve the size of grains and seeds, and improve the quality of fruits and vegetables.

The most common symptom of potassium deficiencies are chlorosis along the edges of leaves (leaf margin scorching) that occurs first in older leaves, due to potassium is very mobile in the plant. Because of potassium is needed in photosynthesis and the synthesis of proteins, plants lacking potassium will have slow and stunted growth. In some crops, stems are weak and lodging is common if potassium is deficient. The size of seeds and fruits and the quantity of their production is reduced.

CHAPTER 3

MATERIALS & METHODS

3.1 Field Experiment

3.1.1 Experimental design

A total number of 50 experimental units involving 10 levels of treatments with 5 replications were conducted in greenhouse. The experimental design was a factorial experiment in the form of Complete Randomize Design (CRD).

3.2 Planting process

The study was conducted under controlled conditions (net house) in UPM Bintulu Campus, Sarawak. The herb *Artemisia vulgaris* was grown in the polybag by using mixed soil. Plant cuttings about 3 months old were used with 1 plant cutting grown per polybag. The polybags were arranged randomly.

3.2.1 Fertilizer and treatments

The organic fertilizer that was used is cow manure. There are 10 levels of treatments consisting of 10 different rates of the fertilizer with a control (Table 1). Treatments applied are a mixture of cow manure with mixed soil by volume basis. There were five replications for each treatment (Figure 1).

Table 1: The different fertilizer rates (treatments) with cow manure to soil mixture ratio by volume was used in this experiment

Treatments	Treatment ratio (mixed soil : cow manure)
T0	100% mix soil
T1	90% mixed soil + 10% cow manure
T2	80% mixed soil + 20% cow manure
T3	70% mixed soil + 30% cow manure
T4	60% mixed soil + 40% cow manure
T5	50% mixed soil + 50% cow manure
T6	40% mixed soil + 60% cow manure
T7	30% mixed soil + 70% cow manure
T8	20% mixed soil + 80% cow manure
T9	10% mixed soil + 90% cow manure

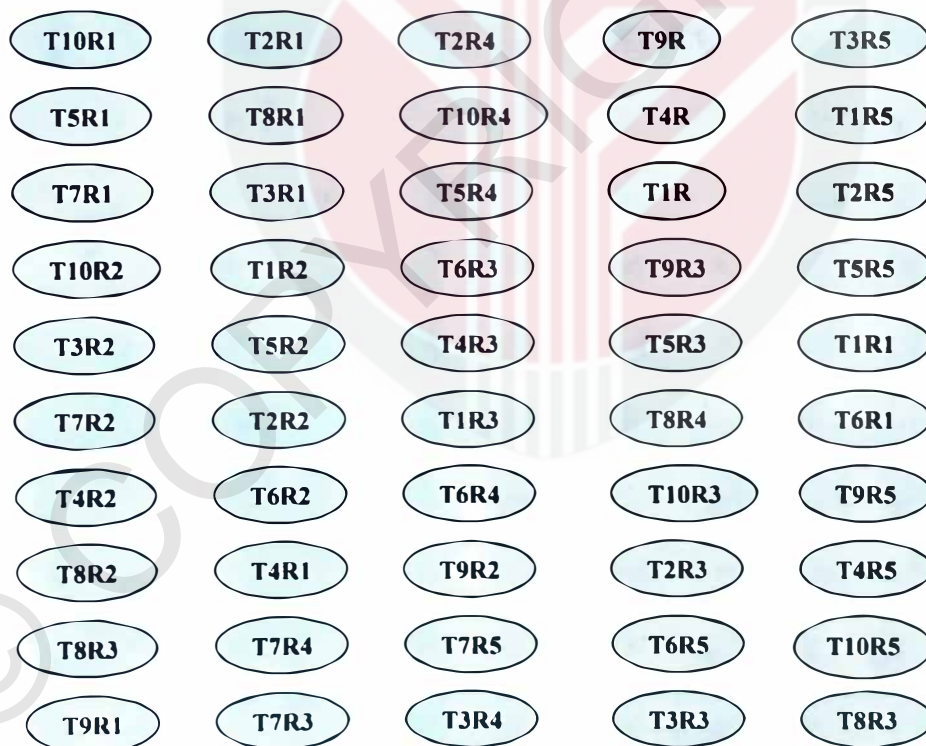


Figure 1: Layout of experimental units

T: Treatment
R: Replicate

3.2.2 Data collection

During the growth period of about four months, plant height for each treatment was recorded monthly. Other parameters which were observed and analysed are selected foliar nutrient concentrations after harvest and nutrient concentrations in the soil before planting and after harvest.

3.3 Laboratory analysis

3.3.1 Determination of Total N concentration in the soil

Total N was determined using micro-Kjeldahl method (Bremner, 1965). Half gram of soil were weighed into 50 ml Kjeldahl digestion tubes and treated with five ml concentrated sulphuric acid and one tablet of Kjeldahl catalyst (mixture of high selenium and Sodium Sulphate anhydrous) added to each sample. The samples were shaken and allowed to equilibrate for 30 minutes after which they were digested on digestion block in a fume chamber. The samples were initially heated at 180 °C for one hour and then to 320 °C for four to five hours until the samples became colourless and were then allowed to cool down. Afterwards, the samples were transferred into 100 ml volumetric flasks, diluted to volume using distilled water and then filtered through Whatman filter paper number two. Ten milliliters of the filtrates were distilled with 10 ml of 40% NaOH and the ammonium collected into Erlenmeyer flask containing 10 ml of 20% boric acid indicator mixture (bromocresol green-methyl red). Total N was determined by titrating the distillates with 0.01 M HCl.

Percentage nitrogen in the soil was calculated as :

$$\% N = [(V-B) \times M \times R \times 14.01 / Wt \times 1000] \times 100$$

Where: V = Volume of 0.01 M HCl or H₂SO₄ titrated for the sample (ml)

B = Digested blank titration volume (ml)

M = Molarity of HCl or H₂SO₄ solution

14.01 = Atomic weight of N

R = Ratio between total volume of the digest and the digest volume used for distillation

Wt = Weight of air-dry soil (g)

3.3.2 Determination of Total P concentration in the soil

Total P was determined by using aqua regia method. Five grams of soil sample was soaked overnight in 50 ml of aqua regia solution (mixture of three parts of concentrated hydrochloric acid and one part of concentrated nitric acid by volume). Next, it was digested at 180 °C to 200 °C for one hour on a hot plate. The sample was then transferred into a 100 ml volumetric flask and added with distilled water to make-up to 100 ml in volume. Total P was then analyzed by using a spectrophotometer.

3.3.3 Determination of exchangeable K concentration in the soil

In this research, the double acid method (Tan, 1996) was used to extract the exchangeable K, Ca, Mg, Zn, Cu and Na in the soil. Forty milliliters of 0.05 M HCl : 0.025 M H₂SO₄ and another 40 ml of distilled water were added to 10 grams of soil samples in plastic vials. The plastic vials were then shaken for 10 minutes in a shaker

proved at 180 rpm. The samples were then filtered into new sets of plastic vials and filtered using Whatman paper number 2. The solutions were then analyzed by using the Atomic Absorption Spectrophotometer (AAS).

3.3.4 Plant Analysis

Determination of total N concentration in plant tissue used the same method as soil analysis by using micro-Kjeldahl method (Bremner, 1965). Furthermore, Cottenie (1980) said determination of P and K in plants tissue could be done by using dry ashing method (single dry ashing). Some samples of plant parts were initially oven dried for 24 hours at a temperature of 60 °C after which they were cooled in a desiccator and 0.5 g weighed into crucible and placed in a muffle furnace and initially ashed at 300 °C for 1 hour and the temperature was raised to 520 °C for four to five hours.

A few drops of distilled water were added to the samples, followed by two milliliters concentrated HCl. Samples were evaporated to dryness in a fume chamber. Ten milliliters of 20% HNO₃ was added to the samples and heated on a hot plate in a fume chamber for one hour. The samples were filtered through Whatman filter paper number 2 into volumetric flask of 100 ml and diluted to volume. The solutions were analyzed for P concentration by using spectrophotometer and exchangeable K, Ca, Mg, Zn, Cu and Na concentrations by using AAS.

3.4 Plant Biomass

The plant samples were cleaned to remove dust and fertilizer residues by washing the plant with water. All parts of the plants (leaves, stems and roots) were weighed to get the fresh weight. The samples were dried in an oven at 65 °C for 24 hours. After drying, the samples were weighed to get the dry weight. The following formula was used:

$$\text{Sample weight} = \frac{(\text{Fresh weight} - \text{dry weight})}{\text{Fresh weight}}$$

3.5 Data analysis

All data collected were analyzed using analysis of variance (ANOVA) followed by Duncan's multiple range test (DMRT) to evaluate significant differences in mean comparison among each level of treatments at $P \leq 0.05$.

CHAPTER 4

RESULTS & DISCUSSION

The results gathered from this study include data on soil before and after harvesting, plant height and N, P and K uptake on *Artemisia vulgaris*. In addition for the nutrient uptake, plant biomass was also included. Data on the effect of different treatment level of cow manure applied to the soil were recorded and statistically analyzed.

4.1 Plant Parameter

4.1.1 Plant Height

The height of all 30 seedlings was measured once in three weeks for a period four months. The detailed results for height measurement are given in Appendix 1. It is graphically depicted in Figure 2.

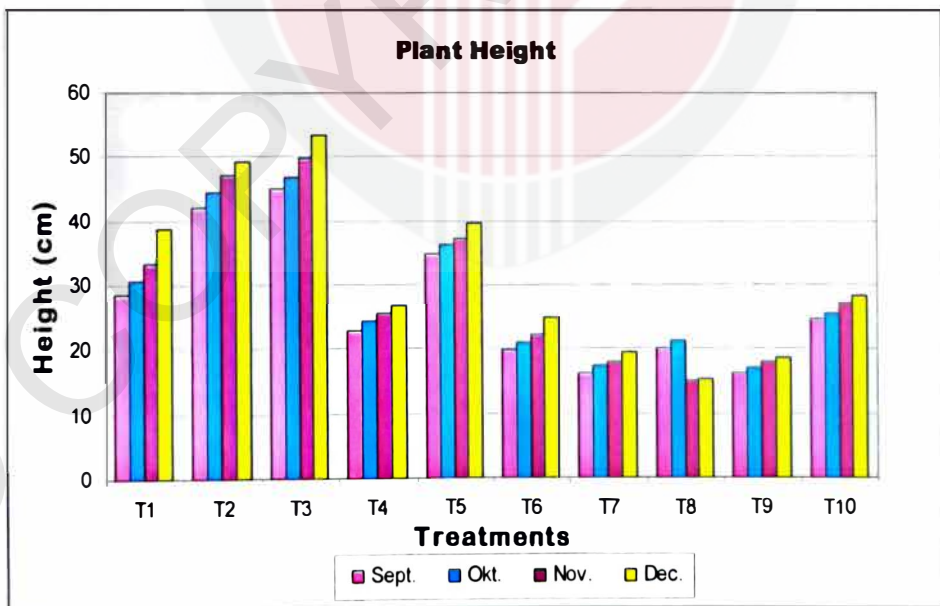


Figure 2: Heights of *Artemisia vulgaris*

As shown in the Figure 2, treatments T1 to T9 represent increasing levels of fertilizer, while T10 is the control without fertilizer. At the end of the fourth month (December 2008), T3 recorded the highest plant height while T8 recorded the shortest plant height. In terms of plant height, T3 appears to be the optimum cow level for plant growth while T9 recorded the lowest plant height. This is probably due to the shock effect of the plant roots during the first month after planting since it recorded small increase in plant height.

As shown in the above figure, T3 gave the highest height of 54.8 cm in 4th months and the lowest height of 16.10 cm was attained by T9. In terms of height growth, the total heights of all treatments are in the following order from highest to lowest: T3 (53.27 cm), T2 (49.33 cm), T1 (38.77 cm), T5 (39.60 cm), T10 (28.20 cm), T4 (26.80 cm), T6 (24.83 cm), T7 (19.60 cm), T9 (18.70 cm), T8 (15.37 cm), consecutively.

Table 2: Treatment effects on plant height

Treatment	Mean (cm)
T1	32.74ab
T2	45.74ab
T3	48.73a
T4	24.87ab
T5	37.01b
T6	21.90ab
T7	17.79c
T8	17.91c
T9	17.47c
T10	26.36ab

Note: Means with the same alphabet are not significant difference at $p \leq 0.05$

From statistical analysis, T3 and T9 are significantly different ($P \leq 0.05$). There was significant difference among treatments (Table 2) except for T7, T8 and T9 which are not significantly different.

4.1.2 Plant Biomass

The results of plant biomass are presented in Table 3. The table shows that there was no significant difference among the treatments. Treatment 7 has the highest mean weight for leaves, stems and root with a value of 0.83g while the lowest mean of weight for leaves, stems and root was Treatment 8 with a value of 0.76g.

Table 3 : Plant total biomass

Treatments	Total biomass
	-----gramme(g)-----
T1	0.78 ^a
T2	0.79 ^a
T3	0.79 ^a
T4	0.81 ^a
T5	0.80 ^a
T6	0.81 ^a
T7	0.83 ^a
T8	0.76 ^a
T9	0.76 ^a
T10	0.75 ^a

Mean values followed by the same letter are not significantly different at $P < 0.05$ of Duncan's Multiple Range

4.2 Plant Nutrient Uptake

The results of the N, P and K uptake by *Artemisia vulgaris* leaves for every treatment levels of cow manure are given in Table 3. There was no significant difference among the treatments. The highest level of N element uptake by the leaves was 0.14% in Treatment 7. The lowest level of N uptake was T8 with the value of 0.04%. Total N uptake for the other treatments in are as follows: T7 (0.14%), T10 (0.12%), T6 (0.12%), T3 (0.11%), T1 (0.11%), T4 (0.09%), T9 (0.08%) T2 (0.06%) T5 (0.05%) and T8 (0.04%), respectively.

For P uptake by *Artemisia vulgaris* leaves, T7 has the highest level of P element with 0.08%. The lowest level of P was T5 with a value of 0.03%. There was no significant difference in P uptake between the treatments. Total P uptake for the other treatments in are as follows: T7 (0.08%), T10 (0.07%), T3 (0.06%), T4 (0.06%), T1 (0.05%), T8 (0.05%), T6 (0.05%), T2 (0.04%), T9 (0.04%) and T5 (0.03%), respectively.

For K uptake by the leaves, T4 has the highest with a value of 0.85% K nutrient uptake and T9 was the lowest with a value of 0.36%. There was no significant difference in K uptake between the treatments. Total K uptake for the other treatments in are as follows: T4 (0.85%), T3 (0.81%), T6 (0.79%), T7 (0.75%), T1 (0.58%), T5 (0.54%), T10 (0.52%), T8 (0.46%), T2 (0.44%) and T9 (0.36%), respectively.

Furthermore, the highest level for the N uptake on the *Artemisia vulgaris* stem was T7 with a value of 0.17% N while the lowest was T3 with a value of 0.06%. There was no significant difference among the treatments.

Table 4 : N, P and K uptake by plant

	Total N	Total P	Total K
	-----%-----		
Treatments			
Leaves			
T1	0.1060 ^a	0.0540 ^a	0.5840 ^a
T2	0.0570 ^a	0.0377 ^a	0.4397 ^a
T3	0.1067 ^a	0.0630 ^a	0.8090 ^a
T4	0.0920 ^a	0.0593 ^a	0.8510 ^a
T5	0.0463 ^a	0.0350 ^a	0.5403 ^a
T6	0.1167 ^a	0.0503 ^a	0.7913 ^a
T7	0.1390 ^a	0.0840 ^a	0.7507 ^a
T8	0.0403 ^a	0.0530 ^a	0.4597 ^a
T9	0.0873 ^a	0.0377 ^a	0.3577 ^a
T10	0.1220 ^a	0.0713 ^a	0.5237 ^a
Stems			
T1	0.1373 ^a	0.0943 ^a	0.7163 ^a
T2	0.1047 ^a	0.0637 ^a	0.7387 ^a
T3	0.0633 ^a	0.0503 ^a	0.5030 ^a
T4	0.0810 ^a	0.0543 ^a	0.5707 ^a
T5	0.0780 ^a	0.0723 ^a	0.5293 ^a
T6	0.1313 ^a	0.0897 ^a	0.7973 ^a
T7	0.1687 ^a	0.1027 ^a	0.9660 ^a
T8	0.0703 ^a	0.0710 ^a	0.5270 ^a
T9	0.1233 ^a	0.0750 ^a	0.7793 ^a
T10	0.0953 ^a	0.0807 ^a	0.5273 ^a
Roots			
T1	0.2443 ^a	0.0980 ^a	1.1960 ^a
T2	0.2807 ^a	0.1390 ^a	1.8220 ^a
T3	0.1483 ^a	0.1340 ^a	1.7617 ^a
T4	0.1780 ^a	0.1400 ^a	2.1027 ^a
T5	0.1390 ^a	0.0990 ^a	1.9613 ^a
T6	0.3230 ^a	0.0780 ^a	1.5260 ^a
T7	0.2690 ^a	0.2020 ^a	1.6827 ^a
T8	0.0717 ^a	0.1703 ^a	1.6043 ^a
T9	0.3053 ^a	0.0990 ^a	0.9947 ^a
T10	0.3050 ^a	0.1313 ^a	1.1333 ^a

Mean values followed by the same letter are not significantly different at $P < 0.05$ of Duncan's Multiple Range

Total N uptake by the stems for the other treatments in are as follows: T7 (0.17%), T1 (0.14%), T6 (0.13%), T9 (0.12%), T2 (0.10%), T10 (0.09%), T4 (0.08%) T5 (0.08%), T8 (0.07%) and T3 (0.06%), respectively.

For P uptake in the stems, Treatment 7 is the highest level of P with a value of 0.10% and the lowest total P uptake was 0.05% by Treatment 3. There was no significant difference in P uptake between the treatments. Total P uptake for the other treatments in are as follows: T7 (0.08%), T10 (0.07%), T3 (0.06%), T4 (0.06%), T1 (0.05%), T8 (0.05%), T6 (0.05%), T2 (0.04%), T9 (0.04%) and T5 (0.03%), respectively.

For the K uptake on the stems, T7 was the highest treatment with a value of 0.97% and the lowest total K uptake was 0.50 % by Treatment 3. There was no significant difference in K uptake between the treatments. Total K uptake for the other treatments in are as follows: T7 (0.97%), T6 (0.80%), T9 (0.78%), T2 (0.74%), T1 (0.72%), T4 (0.58%), T10 (0.53%), T8 (0.53%), T5 (0.53%) and T4 (0.50%), respectively.

4.3 Soil Nutrient Concentrations Before Planting

4.3.1 Total Soil Nitrogen

Soil nutrient concentrations before planting are presented in Table 5. Total N concentration for Treatment 8 was the highest (0.93%) whereas Treatment 10 (control) had the lowest total N of 0.07%. Total N concentrations for the other treatments are as follows: T8 (0.93%), T7 (0.60%), T4 (0.51%), T3 (0.50%), T1 (0.49%), T9 (0.45%), T5 (0.31%), T2 (0.25%), T6 (0.15%) and T10 (0.07%), respectively. There are significantly different ($P \leq 0.05$) except for T1 and T9 which are not significantly different.

Table 5 : Soil nutrient concentrations before planting

Treatments	Total N	Total P	Exchangeable K
	-----%-----		
T1	0.4853 ^c	0.0897 ^d	0.9097 ^c
T2	0.2520 ^{de}	0.0470 ^f	0.3027 ^c
T3	0.5040 ^{bc}	0.1203 ^c	1.2277 ^a
T4	0.5133 ^{bc}	0.0867 ^d	1.0963 ^b
T5	0.3080 ^d	0.0640 ^e	0.4567 ^d
T6	0.1493 ^{ef}	0.0923 ^d	0.0537 ^e
T7	0.5973 ^b	0.1437 ^b	1.2430 ^a
T8	0.9343 ^a	0.1590 ^a	1.2430 ^a
T9	0.4480 ^c	0.0740 ^e	0.1730 ^f
T10	0.0747 ^f	0.0700 ^e	0.0310 ^e

Mean values followed by the same letter are not significantly different at $P < 0.05$ of Duncan's Multiple Range

4.3.2 Total Soil Phosphorus

Total P concentrations in all treatments are significantly different ($P \leq 0.05$) (Table 5) except for T5, T9 and T10 which are not significantly different. Total P concentration of Treatment 8 was the highest at 0.16% while Treatment 2 was the

lowest at 0.05%. Total P concentrations for the other treatments in descending order: T8 (0.16%), T7 (0.14%), T3 (0.12%), T6 (0.09%), T1 (0.09%), T4 (0.09%), T9 (0.07%), T10 (0.07%), T5 (0.06%) and T2 (0.05%).

4.3.3 Exchangeable potassium

The exchangeable K concentration of Treatment 7 and Treatment 8 showed the highest K concentration with the same value of 1.24% and the lowest was 0.03% in Treatment 10 (control). Exchangeable K concentrations for the other treatments in descending order are as follows: T8 (1.24%), T7 (1.24%), T3 (1.23%), T4 (1.10%), T1 (0.91%), T5 (0.46%), T2 (0.30%), T9 (0.17%), T6 (0.05%) and T10 (0.03%). There was a significant difference among the treatments.

4.4 Soil Nutrient Concentrations After Harvesting

4.4.1 Total soil nitrogen

Soil nutrient concentrations after harvest are presented in Table 6. Total N concentration of Treatment 7 was the highest at 0.28% and the lowest was 0.07% in Treatment 1. Total N concentrations for the other treatments in descending order are as follows: T7 (0.28%), T9 (0.21%), T8 (0.21%), T6 (0.21%), T2 (0.20%), T5 (0.16%), T3 (0.14%), T4 (0.13%) and T10 (0.11%), respectively. There was significant difference ($P \leq 0.05$) in total soil N between all treatments.

Table 6 : Soil nutrient concentrations after harvesting

Treatments	Total N	Total P	Exchangeable K
	-----%-----		
T1	0.0747 ^b	0.0310 ^c	0.0333 ^{de}
T2	0.2007 ^{ab}	0.0667 ^{abc}	0.1557 ^a
T3	0.1447 ^{ab}	0.0480 ^{bc}	0.1043 ^{bc}
T4	0.1307 ^{ab}	0.0753 ^{abc}	0.0830 ^{bc}
T5	0.1587 ^{ab}	0.0790 ^{abc}	0.1163 ^{ab}
T6	0.2100 ^{ab}	0.0803 ^{abc}	0.0930 ^{bc}
T7	0.2753 ^a	0.1027 ^{ab}	0.0977 ^{bc}
T8	0.2100 ^{ab}	0.1253 ^a	0.1053 ^{bc}
T9	0.2147 ^{ab}	0.1220 ^a	0.0647 ^{cd}
T10	0.1073 ^b	0.0450 ^{bc}	0.0040 ^e

Mean values followed by the same letter are not significantly different at $P < 0.05$ of Duncan's Multiple Range

4.4.2 Total soil phosphorus

There was significant differences ($P \leq 0.05$) in total soil P between all treatments (Table 6). Total P concentration of Treatment 8 was the highest at 0.13% while Treatment 10 has the lowest of total P (0.04%). Total P concentrations for the other

treatments as follows: T8 (0.13%), T9 (0.12%), T7 (0.10%), T6 (0.08%), T5 (0.08%), T4 (0.08%), T2 (0.07%), T3 (0.05%) and T10 (0.04%).

4.4.3 Exchangeable potassium

Concentration of exchangeable K in the soil of Treatment 2 was the highest at 0.16% and the lowest was 0.004% in Treatment 10. Exchangeable K concentrations for the other treatments in descending order are as follows: T2 (0.16%), T5 (0.12%), T8 (0.11%), T3 (0.10%), T7 (0.10%), T6 (0.09%), T4 (0.08%), T9 (0.06%), T1 (0.03%) and T10 (0.004%) are not significantly different ($P \leq 0.05$) while T1, T3, T4, and T7 were significantly different (Table 6).

CHAPTER 5

DISCUSSION

5.1 Effects of cow manure on plant height

The growth performance of *Artemisia vulgaris* on height of plant showed in Figure 2. The growth of *A.vulgaris* on T3 gave the highest of plant height compared to other treatments. T3 is a 70% of cow manure mixed with 30% soil mixture. Cow manure has long been recognized as perhaps the most desirable of these natural fertilizers because of its high nitrogen content (Sloan, D.R. *et al.*, 2000). It could be probably due to excess of nitrogen can adverse effects on the vitality of plants. According to Plaster (2003), the function of the N is to promote vegetative growth but too much N can cause the plant to slow down maturity and crop ripening. Medicinal plant is a plant usually collected from wild (Joy *et al.* 1998), where they can growth well although no manure applied. Amujoyegbe *et al.* (2007) stated organic fertilizer applied to the soil supply plant nutrients for crop growth and may adversely affect the plant physiological processes.

The growth of *A.vulgaris* may not be affected by application of fertilizer but influenced by the other environmental factors including light, temperature and water.

Water is essential for all plants and is an integral part of living systems. Water is ecologically and biochemically important because it is a major force in shaping climatic patterns, and component in physiological processes in plants. Temperature and precipitation act together to affect the physiological and ecological status of plants. The biological situation of a plant is determined by the balance between

rainfall and potential evapotranspiration. When rainfall is lower than potential evapotranspiration demand, a water deficiency exists (Manske, 2000). Imbalance of environmental factors can be inhibiting factor for optimum plant growth.

5.2 Biomass and Nutrients Uptake

According to Migliaccio *et al.* (2007), the general insignificant different in the nutrient concentration treatment and might reflected in the insignificant dry weight and nutrient uptake in leaves upon fertilizer. Refer to Table 4, T7 was the highest of nutrient uptake by *A.vulgaris* stems for all the nutrients. For N uptake by leaves on T7 was the highest of weight of leaves. According to J.A. Silva (2000), nitrogen promotes growth and increases biomass production of trees and nitrogen fertilization has been used to increase wood production and forest growth.

Refer to Table 5, the nutrient concentration in soil before planting was higher than soil after harvesting except P concentration. The nutrient concentration in soil probably was taken up by plants and to be leached from the soil. N concentration in soil after harvesting of T10 was not significant different between T1 until T9. T7 was highest of N uptake by *A.vulgaris* leaves. According to Brady and Weil (2002), plants roots taken up nitrogen from the soil solution as nitrates (NO_3^-) and NH_4^+ ions. N was needed by plant for building blocks of the all protein and to stimulate root growth and development. Decreasing N concentration in soil after harvesting could be leached from soil. The nitrate ions are not absorbed by the negatively charged colloids that dominate most soils. Therefore, nitrates ions move downward freely leaching from soil (Brady and Weil 2002). Nutrient losses from a sprinkler system also can be very high (Livestock Waste Facilities Handbook, 1985).

The concentration of P in soil before planting was high concentration compare than soil in after harvesting. Therefore, the concentration of P was decrease after harvesting. The phosphorus in the soil is usually taken up by plants in the form of mineral phosphates which usually arise from the weathering of bedrock. Phosphates are virtually immobile in soils, so that at any time, a small proportion of the soil phosphorus will be available to plants (Agriculture and Agri-Food Canada, 1990).

According to Barker and Pilbeam (2007), K uptake by plants is an active process and varies with different plants. Generally, plants absorb K at an earlier growth stage followed by absorbance of N and P. Nutrient uptake by plant depends on nutrient supply in the soil, root surface area, and root activity. K uptake by plants can be in excess when K is surplus in the soil.

The K concentration in soil before planting was decrease in soil after harvesting. K is taken up by plants in large quantities about 5 to 10 times. The decreasing K concentration could be K lost by leaching by rainfall and returned to the soil with the plant residues. A majority of the potassium added to the soil in cow manure is readily available and will either be used by the crop or will be adsorbed on the soil to be used on another occasion (Agriculture and Agri-Food Canada, 1990).

5.3 Nutrient concentrations of *Artemisia vulgaris*

Nutrient concentrations of *A. vulgaris* showed significant increase especially for N, P and K concentrations at different application rates of cow manure. This indicates application of cow manure increased N, P and K. Generally, nutrient supply of plants depends on both soil and plant factors. Availability of the nutrients is the resultant of

a complex of soil factors. They interact with a group of plant properties which can be termed as efficiency of uptake. However, both availability and efficiency largely depend on the contact between nutrients and the root (Havlin *et al.*, 1999).

Results from this study also showed that N in *A. vulgaris* is not necessarily required in large amounts. Requirement of N is depends on plants species and varieties. N accumulation in plants also varies among families. The concentration of N in leaves, stems, and roots changes during growth stage. During the early growth stages, the concentration of N was higher. As plants mature, the concentrations of N in leaves, stems, and roots decreased, and usually independent of the initial external supply of N (Barker and Pilbeam, 2007). According to Barker and Pilbeam (2007), plants absorb specific mineral elements from the soil.

Foliar K was highest compared to other nutrients because of K is very mobile in the plant. K is needed in photosynthesis and synthesis of protein whereby of K deficiency in the plant can cause slow and stunted plant growth (Uchida, 2000).

5.3 Soil nutrient concentrations

Comparison of soil nutrient concentrations before planting (Table 4) and after harvest (Table 6) showed there was an increase in total N, P, K with application of cow manure. This indicates that the application of cow manure improves the availability of nutrients in the soil physical, chemical and biological properties control the availability of plant nutrients. It also increases infiltration of water, enhances retention of nutrients and promotes growth of beneficial organisms (Brady and Weil, 2004). Increasing of total N, P and K after harvest depends on rate of

fertilizer applied, method of fertilizer placement, plant uptake and soil properties that influence nutrient availability (Halvin *et al.* 1999). Gaskell *et al.* (2000) stated the availability of nutrient depends on microbial activity, a lack of mixing with the soil or extremes of soil moisture or temperature will slow nutrient availability of nutrients.



CHAPTER 6

CONCLUSION

In conclusion, application of cow manure on *Artemisia vulgaris* showed significant effects on plant height. The optimum rate of fertilizer which produced the tallest plant was in Treatment 3 that gave the highest height of 54.8 cm in 4th months and the lowest height of 16.10 cm was attained by T9. Plant growth and development are influenced by environment factors such as temperature, light, carbon dioxide, water, and nutrition.

Comparison of soil nutrient concentrations before planting and after harvest showed that there was decrease in total N, P, and K concentrations with application of cow manure. It is probably caused by degradation process by soil organisms. However, exchangeable K decreased probably due to nutrient in the soil was leaching, consumed by soil organisms and uptake by plants.. However, concentrations of foliar N, P and K were not consistent, it is influenced by plant requirement, stage of development, and nutrient availability in the soil.

In addition, for further study, it is advisable to conduct field experiments by planting the herbs in open field. Furthermore, it is more appropriate if the amounts of nutrients needed by the plants are being investigated first before any rate of desired fertilizer is applied to enhance plant growth. Increasing the levels of application rate of cow manure to determine and evaluate the effects of cow manure on plant growth is recommended. For future research addition of different types of fertilizer is also suggested.

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APPENDIX 1

Plant biomass

Plant biomass

unit: g	leaf			stem			root			biomass (g)	
	b4	aft.	tot.	b4	aft.	tot.	b4	aft.	tot.	brt basah(g)	
T1R1	58.9	7.64	51.26	102.8	22	80.8	27.1	8.6	18.5	188.8	0.797458
T1R2	69.4	9.62	59.78	108.6	20.88	87.72	232.3	53.92	178.38	410.3	0.794248
T1R3	9.3	1.57	7.73	19.5	4.65	14.85	41	10.29	30.71	69.8	0.763467
T2R1	27.1	3.37	23.73	42.9	7.62	35.28	59.8	12.56	47.24	129.8	0.818567
T2R2	21	1.82	19.18	93.9	15.75	78.15	195.7	55.25	140.45	310.6	0.765551
T2R3	52.9	6.27	46.63	66.4	13.11	53.29	379	83.48	295.52	498.3	0.793578
T3R1	79.2	13.01	66.19	115	10.74	104.26	433.9	96.78	337.12	628.1	0.808104
T3R2	106.2	5.03	101.17	63.3	8.59	54.71	96.2	19.51	76.69	265.7	0.875311
T3R3	44	10.37	33.63	43.3	22.51	20.79	115.6	25.85	89.75	202.9	0.710547
T4R1	91.1	11.48	79.62	91.9	20	71.9	139.8	31.62	108.18	322.8	0.804523
T4R3	100	10.62	89.38	83.4	15.26	68.14	196.1	26.97	169.13	379.5	0.860738
T4R4	90.9	8.8	82.1	144.3	27.11	117.19	438.9	112.98	325.92	674.1	0.779128
T5R1	70.3	8.25	62.05	68.72	13.19	55.53	161.8	27.65	134.15	300.82	0.836813
T5R2	54.2	8.32	45.88	91.1	21.79	69.31	319.5	77.28	242.22	464.8	0.768954
T5R3	69	8.76	60.24	98	17.39	80.61	326	67.41	258.59	493	0.810223
T6R1	163.7	4.16	159.54	126.4	21.55	104.85	119.7	23.18	96.52	409.8	0.880698
T6R3	51.7	18.19	33.51	38.5	7.62	30.88	168.3	39.92	128.38	258.5	0.745725
T6R3	35.1	7.46	27.64	124.3	25.11	99.19	126.2	20.92	105.28	285.6	0.81271
T7R1	43.2	11.71	31.49	94.2	17.7	76.5	190.1	41.54	148.56	327.5	0.783359
T7R2	71.2	4.93	66.27	120	25.57	94.43	61.7	16.49	45.21	252.9	0.814195
T7R3	127.5	11.31	116.19	135.8	3.84	131.96	253.7	47.54	206.16	517	0.878743
T8R1	22.1	3.07	19.03	39.9	3.84	36.06	157.8	3.7	154.1	219.8	0.951729

T8R2	18.5	2.68	15.82	16.6	6.73	9.87	64.6	40.01	24.59	99.7	0.504313
T8R3	36.3	4.36	31.94	56.8	10.69	46.11	140	28.35	111.65	233.1	0.813814
T9R1	15.5	2.38	13.12	71.4	16.26	55.14	39.1	14.58	24.52	126	0.736349
T9R2	14.3	1.22	13.08	12.4	3.46	8.94	44.4	12.77	31.63	71.1	0.754571
T9R3	7.2	2.1	5.1	15.8	2.5	13.3	36.6	7.64	28.96	59.6	0.794631
T10R1	52.8	8.97	43.83	103.4	28.88	74.52	9.5	2.56	6.94	165.7	0.756126
T10R2	68.2	11.32	56.88	96.7	25.59	71.11	235.9	58.4	177.5	400.8	0.762201
T10R3	33.2	5.96	27.24	44.1	13.53	30.57	130.1	31.92	98.18	207.4	0.752122

APPENDIX 2
N plant uptake

	N plant uptake		Total N %	N uptake %	N uptake %	total N uptake in
	total N %	N Uptake	stem	stem	root	plant %
	Leaf	% Leaf				
T1R1	0.490	0.133	0.490	0.210	0.048	0.391
T1R2	0.946	0.138	0.490	0.105	0.508	0.751
T1R3	0.420	0.047	0.455	0.097	0.177	0.321
T2R1	0.350	0.064	0.490	0.133	0.089	0.287
T2R2	0.560	0.035	0.525	0.132	0.262	0.429
T2R3	0.771	0.072	0.455	0.049	0.491	0.611
T3R1	0.245	0.026	0.385	0.064	0.108	0.198
T3R2	0.665	0.253	0.420	0.087	0.243	0.582
T3R3	0.245	0.041	0.385	0.039	0.094	0.174
T4R1	0.630	0.156	0.455	0.101	0.250	0.507
T4R3	0.350	0.082	0.385	0.069	0.150	0.301
T4R4	0.315	0.038	0.420	0.073	0.134	0.246
T5R1	0.315	0.065	0.490	0.091	0.108	0.264
T5R2	0.350	0.035	0.420	0.063	0.172	0.269
T5R3	0.315	0.039	0.490	0.080	0.137	0.255
T6R1	0.876	0.341	0.490	0.125	0.305	0.771
T6R3	0.701	0.091	0.420	0.050	0.381	0.522
T6R3	0.701	0.068	0.630	0.219	0.283	0.569
T7R1	0.665	0.064	0.455	0.106	0.351	0.521
T7R2	0.806	0.211	0.665	0.248	0.196	0.656
T7R3	0.630	0.142	0.595	0.152	0.260	0.554
T8R1	0.105	0.009	0.315	0.052	0.039	0.100
T8R2	0.490	0.078	0.630	0.062	0.107	0.247
T8R3	0.245	0.034	0.490	0.097	0.069	0.200
T9R1	0.630	0.066	0.525	0.230	0.169	0.464
T9R2	0.771	0.142	0.490	0.062	0.378	0.581
T9R3	0.630	0.054	0.350	0.078	0.369	0.501
T10R1	0.630	0.167	0.385	0.173	0.137	0.477
T10R2	0.981	0.139	0.315	0.056	0.552	0.747
T10R3	0.455	0.060	0.385	0.057	0.226	0.342

APPENDIX 3

P plant uptake

	P plant uptake					
	total P % Leaf	P Uptake % Leaf	Total P % stem	P uptake % stem	P uptake % root	total P uptake in plant %
T1R1	0.252	0.069	0.283	0.121	0.012	0.201
T1R2	0.487	0.071	0.376	0.080	0.235	0.386
T1R3	0.198	0.022	0.386	0.082	0.047	0.151
T2R1	0.435	0.079	0.486	0.132	0.144	0.356
T2R2	0.307	0.019	0.123	0.031	0.185	0.235
T2R3	0.165	0.015	0.258	0.028	0.088	0.131
T3R1	0.396	0.042	0.441	0.073	0.205	0.320
T3R2	0.276	0.105	0.233	0.048	0.089	0.242
T3R3	0.255	0.042	0.297	0.030	0.108	0.181
T4R1	0.278	0.068	0.350	0.078	0.077	0.223
T4R3	0.253	0.060	0.361	0.065	0.093	0.218
T4R4	0.411	0.050	0.113	0.020	0.250	0.320
T5R1	0.193	0.040	0.461	0.085	0.037	0.161
T5R2	0.220	0.022	0.413	0.062	0.086	0.169
T5R3	0.355	0.043	0.427	0.070	0.174	0.287
T6R1	0.202	0.079	0.467	0.096	0.003	0.178
T6R3	0.376	0.049	0.513	0.061	0.171	0.281
T6R3	0.241	0.023	0.323	0.112	0.060	0.196
T7R1	0.618	0.059	0.383	0.090	0.335	0.484
T7R2	0.339	0.089	0.253	0.095	0.092	0.276
T7R3	0.462	0.104	0.483	0.123	0.179	0.406
T8R1	0.361	0.031	0.550	0.090	0.222	0.343
T8R2	0.496	0.079	0.560	0.055	0.116	0.250
T8R3	0.356	0.049	0.344	0.068	0.173	0.290
T9R1	0.087	0.009	0.039	0.017	0.038	0.064
T9R2	0.415	0.076	0.663	0.083	0.154	0.313
T9R3	0.323	0.028	0.558	0.125	0.105	0.257
T10R1	0.467	0.123	0.328	0.148	0.082	0.353
T10R2	0.466	0.066	0.238	0.042	0.246	0.355
T10R3	0.190	0.025	0.351	0.052	0.066	0.143

APPENDIX 3

K plant uptake

	K plant uptake					
	total K % Leaf	K Uptake % Leaf	Total K % stem	K uptake % stem	K uptake % root	total K uptake in plant %
T1R1	3.544	0.962	2.084	0.892	0.972	2.826
T1R2	3.711	0.541	3.031	0.648	1.759	2.948
T1R3	2.245	0.249	2.861	0.609	0.857	1.714
T2R1	4.246	0.776	3.980	1.082	1.618	3.476
T2R2	3.805	0.235	3.038	0.764	1.914	2.913
T2R3	3.291	0.308	3.456	0.370	1.934	2.612
T3R1	4.145	0.437	3.539	0.587	2.325	3.350
T3R2	3.514	1.338	2.824	0.581	1.156	3.076
T3R3	3.936	0.652	3.325	0.341	1.804	2.797
T4R1	4.306	1.062	3.109	0.692	1.710	3.464
T4R3	3.768	0.887	3.213	0.577	1.779	3.243
T4R4	4.963	0.604	2.548	0.443	2.819	3.866
T5R1	3.684	0.760	3.483	0.643	1.680	3.083
T5R2	2.626	0.259	2.505	0.374	1.387	2.019
T5R3	4.924	0.602	3.490	0.571	2.817	3.989
T6R1	3.970	1.546	4.796	1.227	0.724	3.496
T6R3	3.216	0.417	2.529	0.302	1.679	2.398
T6R3	4.244	0.411	2.486	0.863	2.175	3.449
T7R1	5.400	0.519	3.523	0.823	2.888	4.230
T7R2	3.844	1.007	3.470	1.296	0.827	3.130
T7R3	3.230	0.726	3.054	0.779	1.333	2.838
T8R1	2.904	0.251	4.386	0.720	1.793	2.764
T8R2	3.859	0.612	3.729	0.369	0.965	1.946
T8R3	3.764	0.516	2.489	0.492	2.055	3.063
T9R1	3.030	0.316	2.978	1.303	0.613	2.231
T9R2	3.006	0.553	2.755	0.346	1.369	2.268
T9R3	2.385	0.204	3.088	0.689	1.002	1.895
T10R1	2.993	0.792	2.023	0.910	0.562	2.263
T10R2	3.433	0.487	2.066	0.367	1.763	2.616
T10R3	2.223	0.292	2.068	0.305	1.075	1.672

PUBLICATION OF THE PROJECT UNDERTAKING

This is to certify that I have no objection to publish the project entitle “**Effects of Cow Manure on The Growth of Baru Cina (*Artemisia vulgaris L.*)**” by the supervisor in a joint authorship. However, it has to be evaluated by the Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus and published in the form approved by the Faculty.



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