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Combination of Host and Configuration Plant on Entisol Soil for Sandalwood Growth

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ABSTRACT

This research aims to analyze the effect of symbiont, planting space, configuration, physical and Sandalwood chemical characteristics of Entisol. As a parameter of this research used physical soil include bulk Legume density, porosities, water content, soil texture, and for the sandalwood tree using height, diameter. As Configuration a result of research show the bulk density 1,23 to 1,56 g/cc; porosities 41,13 to 53,58%; water content Soil Characteristics 0,30 to 9,00%, moisture content 18,30 to 26,78%; and clay content 37,60 to 5,22%. Chemical soil observed include nitrogen, C/N ratio, phosphor (P)-available, and potassium (K)-available, pH, cation exchange capacity, and base saturation (BS). The contribution of nitrogen to sandalwood growth between 0,06-0,23%; phosphor 7,14-30,89 ppm; ratio of C/N 8,40-19,42; potassium 342,43-359,94 ppm; acidity 6,70-7,80; CEC 14,30-16,14; and BS 79,90-102,93. Unsuitable using sesbania for primary host and configuration planting is not significant with Alternanthera for sandalwood growth by using the legume crops with 6 symbiont and 10 cm planting spacing. The local host Alternanthera sp with configuration and planting space (6; 10 cm) in the cultivation of sandalwood with clayey texture 42,62% and moisture content (22,56%) and are supported by sufficient and balanced nutrition, will be provide a good growth of sandalwood.

INTRODUCTION

Sandalwood is a plant parasite earlier in life at the seedling stage during in the nursery side, this type requires a host tree to support its growth, because the roots themselves are not capable of supporting life or nutrients from the soil with the exception of the elements calcium (Ca), and therefore this is the prerequisite of sandalwood is difficult to breed or cultivated. Staple crop roots do not develop properly also result in physical and chemical soil properties such as the formation of soil process [1], [2]. Amount of soil pores that little causes increased soil compaction (bulk density) so that the effect also for plant growth. The nutrients taken from the host is nitrogen (N), phosphorus (P), potassium (K), but the elements calcium (Ca) collected from the ground [3], [4]. Host plants also serves as a shade when the sandalwood is still in the seedling stage. Sandalwood with host turi live better than the seedlings without a host, and that N and P are not able to improve the quality of seedling growth of sandalwood, which suggests that the roots of sandalwood are less able to absorb N and P are effectively [5]. *Sesbania grandiflora* can be adapted to acid soils infertile, sometimes also thrives in waterlogged soil beans are more adaptable than the other peanut plants, drought tolerant [6]–[8]. Non legume plants such as has a fibrous root, which contains a lot of water so that it can survive in a dry area [9]–[12]. Growing it is often planted on the boundaries of the road and sometimes planted on soils slightly tilted to prevent erosion [13]–[15]. Plants non legume other that casuarina has leaves apparent, which is actually a green branches and including fast- growing tree species in dry climates that can function as both a host plant secondary and can also be used as a shade tree for early plant sandalwood [16], [17].

Sandalwood growth mechanisms depend on how far the roots getting the nutrition from the host. Most of the land in East Timor dominated by soil Entisol [18]–[21]. Entisol soil is soil structure formation is still young, and formed by deposition of soil during the rainy season that comes from the highlands to the lowlands to the profile then formed on the surface of the low-lying, soil is generally thin with effective depth of 50 cm. Rock layers between topsoil with this limiting factor in the development of agricultural land in East Timor, so that the land is only able to be developed for crops or other plants that have a shallow root zone [9]. The growth of a plant is determined by the soil-forming parent materials which affects the amount of nutrients taken up by the plant either host or sandalwood. Differences in the intake of nutrients or nutrients taken up by the host will have an effect on the nutritional contribution to plant sandalwood will be an important study on the role of host Legume and non legume, plant spacing and planting configurations for plant growth sandalwood in order to better

development. Basically, the soil is a layer on the surface of the earth, but not rock solid form, with the spread horizontally and vertically different from one region to another.

The properties of the soil is always heterogeneous from one place to another place. This is because the land as a place of human beings, animals and plants as well as the foothold to perform routine activities. Human influence on changes in soil properties due to concomitant occurrence of a large enough population growth, so the need for food will increase causing competition in the use of land so as to encourage people to do the opening of new land. Land is also a natural object consisting of heterogeneous components of solid, liquid and gas, and has the properties and dynamical behavior. These natural objects are formed by the result of the interaction between climate and life the bodies of the parent material is influenced by its place reliefs formed and time [22]–[24]. Soil strongly supports the activities of human life and other organisms. and it can be said, without any ground, almost every kind of activity of human life will be disrupted. The difference of each factor also lead to differences in the type and characteristics of the soil is formed. Sand-textured soil characteristics which have a surface area (specific surface) is small, making it difficult to absorb or retain water and nutrients, so that the dry season is short of water. When the amount of sand is not too much, the effects on soil would be good, because it is quite loose, water will be easily absorbed, and is quite contained soil, soil air and ground easily fit easily processed [22]. In connection with the shelf life of water, sand soil have binding power of the soil moisture is relatively low, because the contact surfaces between the surface of the soil with water at a finer texture soil and sand soil is dominated by macro pores [9], [25], [26].

The physical properties of the soil plays an important role in supporting the growth of plants. The physical properties of the soil, such as the contents and density of soil strength has long been recognized as a major parameter in assessing the success of soil tillage techniques [27]–[32]. Texture soils determine the physical properties of the soil where soil texture shows the ratio of grains of sand (2mm - 50μ), dust (2μ-50 μ), and clay (<2μ) in fine soil fraction [30]. The relative size of the soil particles is expressed in terms of texture or roughness refers to the fineness of the ground [28]. Land dominated by the dust will have few pores somewhat porous and predominantly clay will have micro pores or not porous [33]. Plant sandalwood is one of the commodities that have a sizeable market opportunities in East Timor. Growth sandalwood is very closely related to the environment because it is hemi parasite during sandalwood growth, especially regarding the condition of the land. By because it considering Entisols a relatively poor soil favorable to plant growth not only of sandalwood alone commercial and noncommercial, then in need effort to increase productivity. In addition to the soil texture of soil physical properties, physical properties of soil are called the soil structure. Soil structure is a natural small clumps of soil, due of primary grains of soil from each other. One unit structure called the formed by natural processes. Soil structure has a shape that is different, namely plates, prismatic, host, glob-angle, glob rounded, granular, crumb [34].

The physical properties of soil is usually interpreted to mean bulk density or bulk density which shows a comparison between dry weight of soil with soil volume including pores of soil that can be used to calculate the total pore space total porosity of land on the basis that the density of particles soil is 2.65 g/cc [35]–[37]. High bulk density which causes the smaller room structure and the smaller pore spaces. High bulk density that obviously affects the permeability of plant roots in the soil, and the rate of diffusion of O_2 in the pores of the soil so that the respiration of roots disturbed. Magnitude of soil bulk density can be varied from time to time or from layer to layer in accordance with changes in soil pore spaces or structures. The diversity that reflects the degree of soil density, because the soil pore space is reduced and the weight of each unit of land increases lead to increased soil bulk density [36]–[38]. Land with a great weight will be difficult to continue the water or difficult to penetrate the roots of plants, otherwise the soil with a low bulk density, the plant roots more easily develop [39]. So the bulk density is the ratio of the absolute dry weight temperature 105ºC a unit of land to the total volume, which is often expressed in g/cm3 [30].

Characteristics Entisol is likely to have a rough texture with organic content and low nitrogen, soil is easily oxidized by air, moisture and soil acid soil entisols always changing, it is because the ground entisols always wet and low, is due to land entisols always wet and submerged in a basin, and because the land entisols have acid levels are very high or very low. So acidic and less arable depend on soil fertilizer and water supply is controlled, some Entisol can be used for agriculture solum its boundary is a thin, wiry texture, or balance-soil moisture deficit regarding the type of soil types air. Entisol a relatively less favorable for growth plants, making it necessary efforts to increase productivity by way of fertilization. Conventional farming systems have been using chemical fertilizers and pesticides that the higher proportion. Increasing this dose causes the accumulation of nutrients derived from fertilizers / pesticides in water and ground water, which causes environmental pollution. Land itself also will experience burnout and damage caused by such high technology input. Generally Entisols much in trying to both technical and rice cultivation in rain field lowlands. but there also are seeking for horticulture. Entisols Timor Leste is undeveloped land, the soil physical and chemical properties that are less profitable. This land has the consistency unravel Aggregation levels are low, a low nutrient content available. Value soil reaction (pH) Entisols alkalis and rapid permeability. Lands that include fertile largely cultivated population. Lands undeveloped land generally live less well known marginal soils [40]. Upland soils are generally composed of ground ultisol or commonly known as red-yellow podzolic and may also oksisol. Soil texture sandy soil and high iodized are characteristics of the soil that dominates the land in East Timor. In general Entisol is a soil mediterranean and complex ground [41]. Characteristics Entisol cultivated land for rice cultivation both technically and rain fed rice fields in the lowlands. This land has the consistency of loose-loose, lower aggregation level, are vulnerable to erosion and nutrient content stock is low that this land is not fertile. Entisol has a Base saturation varied, the of acidic, neutral to alkaline, CEC also vary both on the horizon A and C, has a C/N ratio <20% where the soil has a rough texture high in organic matter and nitrogen is lower than the ground finer-textured. This is caused by the lower water content and the possibility of a better oxidation in coarse-textured soils naturally also the addition of organic materials is less than the rest of the finer soil. Although there is no leaching of plant nutrients and relatively fertile, to obtain a high yield usually require fertilizer N, P and K. Entisol can also be shared by a great group intended, some of which are hydraquent, tropaquent and fluvaquents. The third great group this is a suborder Aquent is Entisol that have a material sulfidic at a depth ≤ 50 cm of the soil surface mineral or always saturated water and on all horizons below 25 cm There hue predominantly neutral or blue from 10 Y and the colors were changed due to oxidation by air. Saturated water for some time every year or artificially drained [42]–[44].

This Order in areas of the parent material of the deposition of new materials or in areas where the rate of erosion or deposition is faster than the rate of soil formation, with vegetation of the area of the river and the coast, such as dunes area, an area with a steep slope land, and floodplains. Agriculture developed in these lands generally are paddy rice in monoculture or rotated with vegetables / crops. Entisol has a Base saturation varied, the soil acid of acidic, neutral to alkaline, CEC also vary both on the horizon A and C, has a C/N ratio <20% where the soil has a rough texture high in organic matter and nitrogen is lower than the ground finer-textured. This is caused by the lower water content and the possibility of a better oxidation in coarse-textured soils naturally also the addition of organic materials is less than the rest of the finer soil. Land Entisol numerous in areas of alluvial or river sediment and sludge coastal marshes, therefore this land often called Alluvial soil. Age is still relatively young land. Land entisol tend to have a rough texture with organic content and low nitrogen, soil is easily oxidized by air, on land entisol, humidity and soil acid are constantly changing, it is because the soil entisol always wet and submerged in a basin and soils that are high in acid less arable, because it has a very high acid levels or very low [45]–[50]. Entisols includes a group of alluvial soil and soil regosol litosol. Found in a variety of environmental conditions. Entisol covers about 16% of the land surface of the earth that is free of ice.

Entisol had higher levels of clay and organic matter is low, so low water holding capacity, crumb structure until grained and very nest, causing the soil easily pass the water and the water is lost due to percolation. Many entisols texture is sandy and very shallow [45]. Land entisols numerous in areas of alluvial or river sediment and sludge coastal marshes, therefore it is often called the land of alluvial soil [7]. Entisol occurs in the layer of the atmosphere in the area with the parent material of the deposition of new matrial or in areas where the rate of erosion or deposition is faster than the rate of development of the land. Such as steep slopes, flood plains and dunes. The main criterion entisols order is not the lack of organization of the ground material. These soils show little or non-existent development horizon and resembles the structure or material in a pile of fresh sand and entisol common characteristic is the absence of real progress that profile [41].

Types of soil on entisol have a Base saturation varies from acidic, neutral to alkaline, cation exchange capacity <20, the rough texture levels of organic matter and N is lower than the ground finely textured, it is caused by the low water levels and the possibility of oxidation better in coarse-textured soil naturally also the addition of residual organic matter of the soil that is more subtle. Although this soil rich in nutrients except N but its effects are not experienced weathering. To accelerate the weathering of organic matter needed fertilizer, manure and green forever. Factor affecting entisols formation process is a very dry climate, so the weathering and chemical reactions run very slow, strong erosion can cause materials from soil erosion more than which was formed through the process of soil formation. There are many steep-slope slope, continuous deposition causes the formation horizon slower than precipitation. There is for example in the area around the river flood plains, deltas, valleys, the area around the volcano, coastal dunes. The advantages of this type of soil physical is to have good drainage and aeration. To this drawback is poor soil organic matter and soil nutrients, especially nitrogen. Management of this type of soil should need to enrich the organic matter to improve soil structure and porous and also as a source of nutrient Nitrogen [30], [51]–[55].

2. MATERIAL AND METHODE

2.1 Place and time of research.

This research was conducted at the site of a permanent nursery Ministerio Agricultura, Floresta é Pescas República Democrática de Timor Leste (MAFP-RDTL). The total area for the location of the sandalwood cultivate is 27 m^2 with 36 for trial planting in the field configuration which is the result of the best combination of treatments.

2.2 Material and Instrument of Research

The tools used in the study were observed data tally sheet, plastic bags, stationery, calculators, digital cameras and laptops, data analysis software COSTAT and ArcView/ArcGIS 3.2a, polybag with, meter, water hose, sieve the soil, shovels, sacks, plastic, buckets, analytic, laboratory equipment and auxiliaries wrecker roots.

2.3 Research Method

2.3.1 Experiment configuration planting in the field to determine differences in the growth of sandalwood due to the configuration and spacing of planting and the type of host.

The total area to be use for the experiments is 27 meter square land area, consisting of 36 units. Experimental plots cleared of weeds then performed planting of Legume and Legume not appropriate planting configuration on each level of treatment is performed in conjunction with breeding in the nursery. Planting is done at the beginning of February 2016 and maintained during the period of 6 months or until July 2016. Configuration field planting is 2 host, the host 4, and 6 each host on a distance of 5 cm, 10 cm, 15 cm on the host Legume or not Legume against sandalwood. Each hole configuration is already prepared planting coincided with the nursery, so that the results of this nursery will be taken to the field to be planted on the ground Entisol.

To make the estimation of sandalwood growth using the parameter of high and diameter measurement to make the prediction of the effect of the soil physical and chemical to the sandalwood growth. Analysis of soil characteristics include soil physical properties and chemical properties of soil. Soil samples taken are analyzed in laboratory parameters were observed physical properties, chemical soil. The moisture content of air dried soil is determined that 10 g of dry soil weight reduced absolute dry soil weight divided and multiplied by 100%. Determination of field capacity moisture content is similar to airdry moisture content determination, the difference in the air-dry soil spilled bottle with water up to 2/3 of the tip of the bottle is wet, then the oven to seek absolute dry soil weight. Determination of the texture can be done through the oxidation of organic matter and soluble salts removed from the soil. The remaining material is a mineral consisting of sand, silt, and clay. The sand can be separated by means of wet sieving, as well as dust and clay were separated by precipitation are based on the law stoke. Determination of phosphor-available and potassiumprovided with basic phosphorus in the form of a backup set using 25% HCl extraction. The extractors will dissolve forms of phosphate and potassium compounds approaching the levels of phosphor and potassium available. Potassium is measured by photometer. Cation exchange capacity (CEC) and Base saturation (BS) of land defined by

using a solution of ammonium acetate with acidity 7,0 as cation exchange complex sorption cover.

2.4 Data Analysis

The data were analyzed using analysis of variance (ANOVA) and multiple regression analysis according to the model of the design used for each experiment. Then continued with Duncan Multiple Range Test (DMRT) at test level 5% on average compared between treatments were tested (Gomez, 2007). Data processing is performed by the statistical program COSTAT.
The mathematical model analysis of variance with the basic design of the trial was a randomized block design (RCBD) according. Data were analyzed using analysis of variance. If the F test shows that there is a real difference between the treatment then continued with Duncan Multiple Range Test (DMRT) to see the difference between the treatments.

3. RESULT

3.1 Physical soil properties

The physical properties of the soil were observed, moisture content and soil texture. Based on descriptive analysis on the effect of soil physical properties to the high growth of sandalwood plants with an average height of 118,78 cm or sandalwood plant height ranged between 46,16 cm – 160,76 cm. The results of measurements of the diameter of sandalwood plants also give an average diameter of 0,73 cm diameter range of values ranged from 0,40 cm to 0,98 cm, bulk density ranged from 1,23 –1,56 g/cc, porosities 41,13 – 53,58%, air dry moisture content 10,479% on average in the range of 6, 30% - 15.00% and moisture content of field capacity with an average of 22,562% or a range between 18,25% - 26,95%. For the soil texture main while of soil fraction, it turns out an average of 28,128% or ranged from 18,58% to 37,57%. On average dust fraction 28.038% with a minimum value of 20,62% to 32,66% and the clay fraction with an average of 42,618% or ranging from 37,60% - 53,22%.

3.1.1 The effect of physical soil properties to the high of sandalwood growth

Pursuant to the results of analysis of the effect physical soil to the sandalwood tree, that there is a real relationship between the physical properties of the soil with plant height sandalwood, wherein the physical soil properties effecting to the height of sandalwood is 91,20%. Air-dry moisture content, the water content of field capacity, the levels of sand, silt and clay significant effect on plant height sandalwood.

Based on the value of each fraction soil composed of sand, silt and clay and after classified using the soil texture triangle area or research sites categorized into textured clay, and clay loam. From the fraction of the land as well as associated with the effect on plant growth of sandalwood, seems to provide a high sandalwood varying the spacing of the treatment, the number of hosts given the respective planting configuration.

Configuration in question is the configuration with the planting of 2 host legume and non legume that will be planted alongside crops sandalwood, as well as the configuration of 4 host to the type of legume and non legume and configuration with 6 host. In the group of hosts given, of group legume or legume group not provide high value crops sandalwood also varies. This occurs because the variation of the nutrient supply of the soil is very diverse or varied from one place to another, from the highlands of course not the same as soil nutrients on land with ramps or low-lying topography. Relation between the physical properties of the soil with the type of host, the host with plant spacing of sandalwood, and host configurations used are very significant.

When connected to a high growth of sandalwood plants turns on the configuration of the six host *Alternanthera* sp (purslane) of a kind not legume with a spacing of 10 cm provides maximum plant height of 160.76 cm sandalwood with air dry moisture content of 15.00% of field capacity moisture content has a value of 26.95%, and the texture is Clay Loam. At 6 host configuration also include argillaceous clay texture that affect plant height increment sandalwood are at a spacing of 5 cm to the type of purslane, and 5 cm with pine species.

Instead of the six host the best results, there are the results of other treatments provide a value that varies in different textures. At a spacing of 15 cm with a host *Sesbania grandiflora* and *Alternanthera* sp on a configuration with two host has a height of 108.23 cm to 145.76 for *Cajanus cajan* and *Alternanthera* sp with clayey loam soil texture.

The influence of the water content of dry air, the water content of field capacity, with the type of host legume and configuration with two host turi turned out to have a different value is not real at a spacing of 5 cm, 10 cm and 15 cm, but on condition sand, silt and clay have different values. For this type of *Cajanus cajan*, purslane and fir appeared to have a significantly different value at a spacing of 5 cm, 10 cm and 15 cm for all the physical properties of soil with clay and loam clayey texture.

The physical properties of soil that influence the sandalwood plant height can also be seen from 4 host configuration. In configurations with 4 host is a spacing of 5 cm and 10 cm with the kind of *Sesbania grandiflora* followed by the type of *Cajanus cajan* at a distance of 15 cm as well as the type of purslane with a distance of 10 cm and 15 cm on the type of pine had the texture of clay loam followed by the texture of clay argillaceous on spacing of 10 cm on the type of *Cajanus cajan* and purslane at a spacing of 10 cm that affect plant height increment sandalwood.

3.1.2 The effect of soil physical properties to the diameter of sandalwood growth

The results of multiple regression analysis on the which is an analysis of the relationship of soil physical properties to plant sandalwood diameter growth. There is a real relationship between the physical properties of the soil with a diameter of sandalwood plants. Air-dry moisture content, the water content of field capacity, the levels of sand, silt and clay significantly affect plant diameter sandalwood. Amounting to 95.70% diameter sandalwood plants are influenced by the physical properties of the soil. Effect of physical properties of soil to plant sandalwood diameter growth with 6 host configuration *Alternanthera* sp of a kind not legume with a spacing of 10 cm gives a maximum diameter of sandalwood plants (0.98 cm) with air-dry moisture content at 15.00 % field capacity moisture content or moisture content has a value of 26.95% and argillaceous clay texture.

Therefore, the treatment of the host, a spacing and configuration used turned out to be a configuration with six host of species not legumes provide much better results compared to the treatment with their hosts from the legume. These results indicate that the sandalwood plants cultivated in general does not require special treatment. Clay soil texture has a high water holding ability so having the ability to provide nutrients for plants sandalwood to the growth process.

3.2 Chemical properties

Observation of the chemical properties of soil covering the cation exchange capacity (CEC) and Base saturation (WS), soil acid and nutrient content (nitrogen, phosphor, and potassium), this study showed that soil characteristics entisol provide beneficial effects to the improvement of chemical properties land, which is characterized by an increase in soil chemical properties. Cation exchange capacity, total N, and P-provided land increased markedly in soil characteristics entisol after planting 2 host configuration, 4 and 6 host with varying spacing. Cation exchange capacity (CEC) of the soil increased significantly by 22.35% on soil characteristics entisol with planting 6 host configuration. Cation exchange capacity indicates the ability of soil to hold cations and exchange these cations include the cation plant nutrients. Cation exchange capacity is important for soil fertility. The addition of organic matter will increase the negative charge in the soil thereby increasing the soil CEC. The role of organic matter to the improvement of soil chemical properties not independent in relation to the decomposition of organic matter, because in this process there is a change to the chemical composition of organic material from the complex compounds into simpler compounds. Soil chemical properties observed organic Carbon, the ratio of C/N, N-total, Phosphor-available, potassium-available, soil acid, CEC, and BS. Based on the results of the analysis the chemical properties of the soil are also made to know influence soil chemical properties of the high growth due to the treatment plant spacing of sandalwood, the host, and the configuration of the host plant.

In the chemical properties of the soil, the average value of soil acid 7.2 to soil acid values of 6.6 and maximum 7.8 minimum. For value C with an average value of 2.29% with a minimum Carbon maximum 2.01% and 2.55%, levels of C/N with an average of 11.77% with a minimum value of 8.4% and the highest value for levels of C/N by 19.42%. To determine the value of the cation exchange capacity (CEC) has an average value of 15.13% with 14.3% of the lowest value and the highest 16.14%. Base saturation value (BS) has a central value of 92.94% with 79.9% of the lowest value and the highest 103%. For N-total value has an average value of 0.15% to 0.06% the lowest and the highest was 0.23%. Phosphorus content of 17.51 ppm middle value with lowest value 7.14 ppm and 30.89 ppm highest. The element potassium in the soil that affect the growth of plants with indigo middle sandalwood 352.26 ppm with 342,43ppm lowest value and the highest was 359.94 ppm. Based on analysis of soil chemical properties, it seems that the influence of the host configuration and soil chemical properties has led to changes in plant height increment sandalwood.

3.2.1 Influence of chemical soil properties on the height growth of sandalwood plants

The configuration with 2 symbiont the host of the type of legume with host *Sesbania grandiflora*, a spacing of 5 cm had a growth of sandalwood with a neutral soil acid value, carbon, organic medium, C/N high, CEC is low, BS is very high, N-total is very low, the phosphor-provided is a high level, potassiumavailable is high. A spacing of 10 cm has a growing sandalwood with a soil acid value is neutral, carbon organic is moderate, ratio between carbon and nitrogen namely (C/N) is high, CEC value is low, BS value is very high, very low total-N, Phosphoravailable high- and potassium is high.

Legume species with a host of *Cajanus cajan*, spacing of 10 cm has a growing sandalwood with a neutral soil acid value, the value of organic carbon being, the value of C/N high, low CEC value, BS value is very high, very low total-N, phosphoravailable high, Potassium-available high. With host legume type instead of *Alternanthera* sp, a spacing of 10 cm has a growing sandalwood with a neutral soil acid value, moderate organic carbon, C/N high, low CEC, BS value is very high, very low total-N, phosphor-available high, Potassium-available with a host of high *Casuarina junghuniana*, a spacing of 15 cm has a growing sandalwood with a neutral soil acid value, the value of carbon being, the value of C/N medium, and low CEC, BS very high value, low total-N, Phosphor-available medium, K-provided high. In configuration 4 host of species of legumes to host *Sesbania grandiflora*, a spacing of 15 cm has a growing sandalwood with a neutral soil acid value, the value of carbon of organic being, the value of C/N medium and CEC value is low, the value BS is very high, N-total is low, Phosphor-available medium, Potassium-provided high with a host *Cajanus cajan*, a spacing of 15 cm has a sandalwood growth at neutral soil acid values, the value of organic carbon being, the value of C/N medium and low CEC value, the value is very high birth, N- low total, Phosphor-available medium, Potassium-avalable high. Type is non legume with a host *Alternanthera* sp, a spacing of 10 cm has a growing sandalwood with a neutral soil acid value, the value of carbon organic of being, the value of C/N was, and the value of CEC me / g is low, the value BS is very high, Ntotal is low, P-provided very high, Potassium-provided high with a host *Casuarina junghuniana*, a spacing of 5 cm had a growth of sandalwood with a soil acid value of neutral, the value of carbon organic of being, the value of C/N medium, CEC value me / g is low, the value of BS very high, low total-N, Phosphoravailable high-available K high. In the configuration 6 a host of species of legumes to host *Sesbania grandiflora*, a spacing of 10 cm has a growing sandalwood with a soil acid value of neutral, the value of carbon organic of being, the value of C/N% moderate, and the value of CEC me / g is low, the value of BS very high, N-total is low, the P-provided ppm high, Potassiumprovided ppm high with a host *Cajanus cajan*, a spacing of 15 cm has a growing sandalwood with a soil acid value of neutral, the value of carbon organic of being, the value of C/N is low, and the value of CEC me / g lower, BS value is very high, Ntotal being. Availability of phosphorus or P-provided value of being, Potassium-available high of species not legumes with host *Alternanthera* sp, a spacing of 15 cm has a growing sandalwood with a soil acid value of neutral, the value of carbon organic of being, the value of C/N is low, and the value of CEC me / g is low, the value of BS % is very high, N-total being, Phosphoravailable medium, Potassium-provided high with a host *Casuarina junghuniana*, spacing of 10 cm has a growing sandalwood with a soil acid value of neutral, the value of carbon organic of currently, the value of C/N medium and low CEC value, BS value is very high, N-total being, Phosphor-available high-potassium available is very high. While the control value *Santalum album* without treatment only has the growth of sandalwood with a soil acid value of neutral, the value of carbon organic of being, the value of C/N is low, and the value of CEC me / g is low, the value BS is very high, N-total is low, Phosphoravailable high, very high Potassium-available. In configurations with 4 host legume and non-legume at a distance of 5 cm, 10 cm, 15 cm, it turns out the value of soil chemical properties have significantly different values. However, in a configuration with 6 host legume and non-legume have values that were significantly different compared to the value Control.

3.2.2 Influence of chemical soil properties on the diameter growth of sandalwood plants

Base on the diameter calculation trough Duncan's Multiple Range Test (UJBD) 5% that the increase in diameter of sandalwood plants is strongly influenced also by planting host configuration. Attachment 28 is the result of multiple regression analysis on the analysis of the influence of soil chemical properties of the plant diameter growth of sandalwood, were are amounted to 96.2%, sandalwood diameter influenced by the chemical properties of the soil. The C/N ratio, CEC, WS, N-total, Phosphor-available and Potassium-available, very significant. The affect soil chemistry that influence plant growth sandalwood diameter was still fixed on the host's Configuration 6 *Alternanthera* sp planting at a spacing of 10 cm has a diameter of 0.98 cm no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.2 and a value of C of 2.53%, followed by the C/N ratio of 10.54% and CEC value of 14.43 %, BS value of 79.92%, and the value of N-total of 0.19% and a P-value is available at 30.39 ppm and the most recently available Potassium-value of 354.71 ppm. At a spacing of 15 cm has a diameter of 0.91 cm no significant with a spacing of 5 cm and 15 cm with a soil acid value of 7.8 and a value of C of 2.35%, followed by the C/N ratio of 8.70% and the value of CEC amounting to 14.63%, BS value of 100.88%, and the value of Ntotal of 0.22% and a P value of 7.64 ppm-available and most recently Potassium-value provided at 344.83 ppm. Spacing 5 cm 0.9 cm in diameter had no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.4 and a value of C of 2.21%, followed by the C/N ratio of 9.61% and amounted to 16.12% CEC value, BS value of 89.93%, as well as the value of N-total of 0.18% and a P-value is available at 14.34 ppm and the most recently available Potassium-value of 359.7 ppm.

Casuarina host with a spacing of 15 cm has a diameter of 0.88 cm no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.5 and a value of C of 2.37% followed by C/N ratio of 8.40% and the value of CEC amounted to 14.45%, BS value of 79.9%, and the value of N-total of 0.23% and the value of Phosphor-available amounted to 7.69 ppm, and most recently Potassium-value provided at 345.07 ppm. A spacing of 5 cm has a diameter of 0.87 cm no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.5 and a value of C of 2.23%, followed by the C/N ratio of 9.21% and CEC value at 15, 42%, BS value of 102.88%, and the value of N-total of 0.19% and the value of Phosphor-available 14.29 ppm and most recently Potassium-value provided at 359.94 ppm. While the host *Cajanus cajan* with a spacing of 10 cm has a diameter of 0.86 cm no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.4 and a value of C of 2.51%, followed by the C/N ratio of 11.01 % and amounted to 14.61% CEC value, the value of BS of 100.9%, and the value of N-total of 0.18% and a Pvalue is available at 30.44 ppm and the most recently available Potassium-value of 354, 47 ppm. 4 host configuration *Cajanus cajan* planting at a spacing of 15 cm has a diameter of 0.86 cm no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.5 and a value of C of 2.33% followed by C/N ratio of 9, 03% and CEC value of 15.4%, the value of BS of 102.9%, and the value of N-total of 0.21% and a P value of 7.59 ppm-available and most recently Potassium-value provided by 344.59 ppm. Casuarina host with a spacing of 10 cm has a diameter of 0.86 cm no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.6 and a value of C of 2.55%, followed by the C/N ratio of 10.12% and value CEC amounted to 16.14%, BS value of 89.91%, and the value of N-total of 0.20% and a P-value is available at 30.34 ppm and the most recently available Potassium-value of 354.95 ppm.

Casuarina host configuration planting 2 with a spacing of 5 cm has a diameter of 0.85 cm no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.0 and a value of C of 2.15%, followed by the C/N ratio of 11, 08% and amounted to 15.37% CEC value, BS value of 102.93%, and the value of N-total of 0.14% and a P-value is available at 14.49 ppm and most recently Potassium-value provided by 358.98 ppm. Casuarina host with a spacing of 10 cm has a diameter of 0.85 cm no significant with a spacing of 10 cm and 15 cm with a soil acid value of 7.6 and a value of C of 2.47%, followed by the C/N ratio of 12.11% and value CEC 16.09%, BS value of 89.96%, and the value of Ntotal of 0.15% and a P-value is available at 30.54 ppm and the most recently available Potassium-value of 353.99 ppm.

4. DISCUSSION

High added sandalwood providing host plant legumes and legume at a spacing not different with no significant planting configuration with the treatment of legume that has a high gain low compared with no host. This is because the sandalwood seedlings without a host, sandalwood only utilize nutrients in the soil to improve plant height increment. In the treatment with the legume host is not significantly different from the treatment of purslane and spruce, it is alleged in the treatment of purslane and mountain pine treatment provided will result in the protein synthesis activity accelerate the process of cell division. At the beginning of the reduction in growth, followed by also decreasing the cell wall and protein synthesis in the network. Furthermore, translocation decreased cell division and the anatomically reduced where old leaves dry out and fall resulting in eventual plant death. Greatly influenced the development of a plant when the ground as a place to grow.

The depth of root penetration correlated with the density of the soil and this is shown by the high clay content, namely with an average of 42.62%. The higher the density level ground then diminishing percentage of resistance to root penetration increased. The penetration of the soil by the roots and stems of the sprouts are influenced by the nature of the soil [56]–[61]. Child stem sprouts should urge ground on him so topsoil sprouts break because of power needed for it depends on the thickness and firmness of the soil. In addition, if the physical properties of the soil is not good then the development of plant roots will be disrupted because of the difficulty of these roots make up ground or grown in soil so it would be difficult anyway to take nutrients that are around the plant.

Gomes 2017 in [62] states that the more solid a ground, it is increasingly difficult to pass on the water and are difficult to penetrate plant roots. Likewise, if the more solid a ground it will be increasingly difficult to seed growth and germination in the soil and seed growth will be hampered.

Sandalwood height measurement is very diverse or varied. This diversity allegedly because manifold treatment are used and soil conditions or the different soil characteristics. Because the content of nutrients contained in the soil, not the same for each of the characteristics of the soil in any conditions. The level of diversity is also influenced by the type of host, plant spacing, and planting configuration being used. The results showed that plant height Entisol sandalwood on the ground with a spacing of 10 cm on the configuration of the host plant 6 seems to be higher than the other treatments. Increased acquisition of nutrients and water from the host plant causing apical cell division activity became more active thus spurring higher accretion sandalwood seedlings.

The above data shows that plants cultivated sandalwood along with the type of legume host not *Alternanthera* sp configuration with 6 hosts had the texture of clay. Clay soil texture has a high

water holding ability so having the ability to provide nutrients for plants sandalwood. This is evidenced by the fairly dry moisture content of the air and field capacity at the treatment compared to other treatments.

The results of the analysis, that the rod diameter sandalwood in some age there is no difference. This indicates that the legume host plant for sandalwood has the same effect on seedling stem diameter sandalwood. Under these conditions, there is no difference sandalwood seedling stem diameter due to the host plant both legume and non-legume. There were no differences between the host plant or a combination of host plants of the sandalwood seedling stem diameter due to supply of nutrients from the host plant is no different. As a dicotyledonous plant, stem diameter enlargement or increase the amount of stem diameter due to the activity of the cambium cell division and enlargement or lateral meristem cells.

Nutrients and water that can be donated from the legume host plants did not differ in height increment spur sandalwood seedlings. Increasing age of the plant, the need for nutrients and water more and more. Similarly, the host plant nutrients that can be absorbed by the host plant is widely used for its own metabolic activities from i on donated for sandalwood seedlings. The results also supported by research Wawo, 2013 in [63] that the nutrients needed for the accretion of a plant is high, increase the number of leaves, root growth, the growth of the branch, as well as to increase the size of the trunk. Added diameter rod in the treatment configuration with two host legume no significant effect with treatment 4 host configuration and configuration 6 host that has a trunk diameter of a lower gain type instead of the legume. In configurations with 4 host legume and non-legume at a distance of 5 cm, 10 cm, 15 cm, it turns out the value of soil chemical properties have significantly different values.

However, in a configuration with 6 host legume and non-legume has values were significantly different compared with control values. If a plant does not experience normal growth as sandalwood grows must be accompanied by the host if not then it will be death for not capable of sustaining nutrients for the sustainability of growth. This indicates that the host plant legume legume and not a significant effect on the growth of sandalwood diameter or a combination of host plants have the same effect on seedling stem diameter sandalwood. There is a spacing that influence the growth process sandalwood diameter. Which case that the diameter of sandalwood at a spacing of 10 cm more real than the spacing of 5 cm and 15 cm. As a dicotyledonous plant, stem diameter enlargement or increase the amount of stem diameter due to the activity of the cambium cell division and enlargement or lateral meristem cells.

Based on research data also showed that the value of the lowest phosphor content is at a spacing of 15 cm with a configuration with two host plant, amounting to 7.14 ppm, the highest P value is at a spacing of 10 cm that is equal to 30.89 ppm. Increasing the value of phosphor can occur because the availability of phosphorus depends on the texture of the soil and water availability. Better diffusion of phosphorus in the soil with a smooth texture and moisture content are sufficient [17]. This study also confirmed by research Butarbutar & Faah (2008); Gomes (2013); Lion (2017); Wawo et al., (2008) in [9], that generally, phosphorus in the soil is in a state not soluble, so that in such circumstances it is impossible to get into the root cells. According to the water content in soil research result shows that the value of the highest soil acid is at a spacing of 15 cm that is equal to 7.2-7.5. Referring to Mamatha et al., (2001) in [68] are classified as alkaline soil acid or alkaline (> 7.00). Lowest soil acid value is at a spacing of 10 cm on the type of Sesbania grandiflora on the type of legume that is equal to 6.6 (slightly acidic). Butarbutar & Faah (2008); Gomes (2013) in [69] stated the soil in the planting site classified sandalwood alkalis or fairly neutral. If an area has a soil acid value between 6-7 (neutral), it can be indicated that the land is suitable for various types of plants, just needed a good host that serves to support the growth of sandalwood plants to keep growing. Condition analysis of soil chemical properties with CEC parameters vary greatly. When referring to the opinion form Adler & DeLeo (2020);

Prodjosantoso et al., (2018) in [5], [70]–[72] which states that the intensity of the CEC greatly affect the soil's ability to absorb nutrients and mineral soil. Soils with high CEC value is able to provide better nutrients than soil with a low CEC. Soils with organic matter or with a high clay content have a higher CEC than soils with low organic matter or sandy soils.

The results of the soil analysis showed that the cultivation of sandalwood in soil characteristics that are quite good for plant growth sandalwood. In the end it turns out the high growth of sandalwood influenced by planting configuration but requires nutrients from another plant as host for the growth process. Entisols characteristics turn out to yield a better growth in all configurations of planting while planting configuration itself does not affect the growth process of sandalwood good height, diameter.

Results of research conducted on three factors: plant spacing, host and configuration have soil chemical properties different and each variable response has a range of different limits also vary but in between component chemical properties pH, organic C, C/N ratio, cation exchange capacity, base saturation, total nitrogen, available phosphorus, and potassium they are related to each other so that in the event of changes in the value of each variable response to it will affect the stability of other properties. If the soil acid value increases, there will be a decline in the value of the cation exchange capacity (CEC), the low number of Corganic content, and along with it will cause a decrease of the amount of total nitrogen, and potassium.

5. CONCLUSIONS

Based on the results of the study can be drawn some conclusions as follows:

1. The sandalwood growth better if do cultivate with Alternanthera (krokot) as a non legume species were are using 6 host plant configuration at 10 cm planting space and showed trough diameter and height plant.
2. Entisols characteristics turn out to yield a better growth in all configurations of planting while planting configuration itself does not affect the growth process of sandalwood growth as diameter.
3. Use local host Timor Leste (*Alternanthera* sp) with configuration with a planting space (6; 10 cm) in the cultivation of sandalwood on the ground with clay loam texture (an average of 42,62% clay content) and moisture content of field capacity available in the low level (22,56%) and are supported by sufficient and balanced nutrition, will be provide a good growth of sandalwood.

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