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The Effect of Legume and Non Legume to the Sandalwood (Santalum Album, Linn.) Growth in Timor Leste

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Abstract

Sandalwood plants today are very rare, because the host is not suitable for hemi parasite to supply nutrients for growth. Number of hosts that many will cause growth disorders. Excellence is hosted sandalwood seedlings are growing faster, growing roots, and get sufficient supply of N and Ca, which can not be met if no host. The contribution of individual nutrients from the host plant to plant sandalwood would be better if planted more than one type of host plant. This research was conducted in three stages, from August 2015 through July 2016. Phase I done to establish the area of selection germination and sandalwood conducted over 3 weeks. Phase II trial of treatment is host legume and non legume, a spacing of 5, 10 and 15 cm, using a randomized block design (RCBD) with factorial 3 replications. Factors treatment plant spacing consists of three levels ie J1 = 5 cm, J2 = 10 cm and J3 = 15 cm as well as a control (sandalwood without a host) as a comparison and treatment factors host legume (*Sesbania grandiflora* and *Cajanus cajan*) and non legume (*Alternanthera sp* and *Casuarina junghuniana*). Phase III is the field planting experiment designed by the RCBD 3 replications with factorial 2 factors. The first factor is the plant configuration with 3 levels, namely: 2 host, the host 4, and 6 host. The second factor is the characteristics of the soil at the planting site that is ground Entisol sandalwood. The results of this phase I study showed that the sandalwood seeds after germination by 80% at 25 days after sowing.

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The results of phase II studies also show a spacing and host significant effect on the formation of haustorium more on the roots of seedlings sandalwood with a host of *Alternanthera sp* at a distance of 10 cm (28 per plant roots) (J2AS2), host *Casuarina junghuniana* with a distance of 10 cm (20 per root crops) (J2AS2), host *Sesbania grandifora* with a distance of 5 cm (23 per root) (J1SG1), *Cajanus cajan* at a spacing of 5 cm 19.97 cm (J1CC2). High sandalwood with host *Alternanthera sp* plant at a distance of 5 cm (J1SG1) 48.94 cm, the host *Casuarina junghuniana* at a distance of 5 cm (J2CJ2) (47.03 cm), *Cajanus cajan* at a distance of 5 cm with a height of 45.03 cm (J1CC). Diameter sandalwood with a host *Alternanthera sp* plant at a distance of 15 cm (J3AS1) 1.39 cm, the host *Casuarina junghuniana* at a distance of 10 cm (1.30 cm) (J2CJ2), *Cajanus cajan* at a distance of 5 cm with a height of 1.29 cm (J1CC), *Sesbania grandifora* at a distance of 5 cm with a height of 1.29 cm (J1CC), control with a value of 0.98 cm (J0SA). Number of sandalwood with the host plant leaves of *Alternanthera sp* at a distance of 5 cm, 10 cm and 15 cm are the same ie 16 leaves, evergreen host (14 leaves), *Cajanus cajan* and *Sesbania grandifora* (12 leaves) and control (10 leaves). The results of the phase III study, showed that the legume host plants not significantly affect the formation, height, stem diameter at the age of 60 HSP, HSP 90, HSP 150 and 180 HSP. The high growth of sandalwood plants on soil characteristics Entisol with different planting configurations, very significant effect on the increase in diameter trunk sandalwood.

Based on these results it can be concluded that the use of legume host is not very good to be used as a primary or secondary host for the growth of sandalwood. Legume host type to the type of *Sesbania grandifora* was not suitable to host a nursery or primary host and configuration planting did not affect the growth of sandalwood.

Keywords: Host; Legum; Non Legum; Sesbania; Cajanus; Casuarina; Alternanthera; Plant distance; Configuration; Entisol.

1. Introduction

2.1 Back Ground

The source income of economic Timor Leste is depend on petroleum and gas, while agricultural commodities mainstay of the country's current coffee and forestry are the result of sandalwood (*Santalum album* Linn). Based on data from the National Statistics Forestry Timor Leste, have been exporting 80 tons volume of sandalwood during the exploitation since Indonesia time to Korea and Japan with a price of US $ 8,00 per kilogram or US$. 640.000 equivalent to Rp. 8.512 billion.

Sandalwood (*Santalum album* Linn) has long been recognized as the identity and pride of the Timor island, but the presence of plant sandalwood is now very rare in a country half the island is even endangered. The shortages were caused by the exploitation of sandalwood plants on a large scale but not balanced with rehabilitation and replanting balanced with exploitation. This plant is a plant sandalwood forest is very special because of the economic value and usefulness of the wood is very high [4]. For plants that have high economic value, sustainability needs to be maintained through the efforts of regeneration. The kind that became the mainstay of the country gradually decreased drastically, due to the incompatibility of the host. This is an obstacle in the development of sandalwood always failed because of technological mastery, especially regarding the

management of seeding and planting sandalwood by the public is still low, the lack of institutional support and funding to develop sandalwood [10]. Sandalwood has a fragrant aroma is used as raw material for carving, a variety of craft items, and the results in the form of oil extraction has been traded since 1990. Sandalwood is a plant of the tropics and essential oil-containing compound as santalol [1]. The main characteristics of the component materials. Santalol compound that causes stem and root sandalwood scent issuing so called wood sandalwood scented or fragrant wood. More definition of sandalwood oil traded at a high price because it is used for the basic ingredients in the cosmetics and pharmaceutical industries [41].

In addition, it is crucial for the development of agriculture and forestry is the effective depth of the soil to support intensive farming is a problem that needs to be considered in this country. This is due to the shallowness of the soil because the soil depth an average of less than 50 cm, so that the land is only able to be developed for crops or other plants that have shallow root zone [11]. In principle, this sandalwood plants can grow well on marginal lands and the land is rocky and dry climates, droughts, but this plant is difficult to be planted because it is hemi parasite [37,42]. In developing sandalwood and nearly 90% of the crop sandalwood conducted on farmers' fields while the rest is land owned by the government [6]. One specific biological properties of the sandalwood is the pattern of life that hemi parasite parasitic character as root [28]. As hemiparasitik herbs, sandalwood need host plants to supply nutrients for growth [50]. In the cultivation of sandalwood are two kinds of host, the primary host and the secondary host. The primary host is designated as the host in the nursery, while the host is the host that is planted after seeding, while the secondary host for continued growth to achieve rotations in the field. Sandalwood seedlings can not tolerate direct exposure to sunlight [44]. Host range that many in polybag will cause growth disorders [30]. Therefore, the cultivation of sandalwood typically grown with other plants as host, from the time of growing seedlings to adults [42].

The growth of sandalwood depending on the host for sandalwood can not produce water and nutrients needed by the roots in the growth process, other than that if sandalwood are not getting suitable host, the growth of leaves and tajukanya bit size of small diameter, leaves yellowish or even chlorosis [43]. Excellence is hosted sandalwood seedlings are growing faster, growing roots, and get sufficient supply of N and Ca, which can not be met if no host [40]. Based on experience in the field, sandalwood that grows naturally or without special treatment such as cleaning and fertilizing, growth is much better than those grown. This is caused by the amount of nutrients absorbed by sandalwood from the host more than the natural environment. The contribution of individual nutrients from the host plant to plant sandalwood would be better if planted more than one type of host plant [8]. In addition to nutrients, a growing medium for seedlings sandalwood form polybag size, the ratio of growing medium used, the number of hosts in the pot as well as the sheer number of hosts that will accompany sandalwood in the field and a spacing also determines the success rate of growth of sandalwood. The growth of sandalwood seedlings in pots (polybag) is determined by the type of host plants suitable to accompany sandalwood from planting up to harvesting period [49,50].

Legume is a plant that has long been known as a soil conditioner for its ability menfiksasi nitrogen. Legumes can be wood or nuts are used as the primary host for sandalwood plants are Turi (*Sesbania grandiflora*) and pigeon pea (*Cajanus cajan*) while the non-legume crops are purslane (Alternanthera sp) and mountain pine (*Casuarina junghuniana*) [39]. Turi plant in Timor Leste language known as "ai-kale" is a Legumeinosae plants

that serve as host to the sandalwood plant when it is in the nursery and can also be used as a secondary host plants at planting time in the field. Turi plant is a plant that is suitable for the diversification of agricultural commodities in dry areas and prolonged drought, because it has a high tolerance to drought [35]. Nuts Gude in the language of East Timor, known as "irisi" was chosen because it can meet the requirements into account provides an advantage in terms of adaptation compared to plants kekacangan other, are drought tolerant and can grow in different types of soil, both on fertile soils, acid soils, and soil iodized , This species can also be grown in tropical and subtropical regions, in lowland and highland, resistant to high rainfall intensity and suitable for a wide range of soil conditions, hold the pods fall and not easily broken [46]. The drawback is sensitive to the pod borer, but has the potential to be developed. Pigenon pea beans includes beans are legumes [9]. Purslane plant in Timor Leste language known as "such" is one type of horticultural crops are included in the types of flowers. These plants can be grown in mountainous areas and can also be grown in lowland areas [33]. Purslane has a hairy roots that contain lots of water, which can be used as a host plant for the breeding of sandalwood, because purslane may be able to provide nutrients to plants sandalwood and also could survive in areas with dry climate.

Selection of the mountain pine because this type can grow on a variety of relief or topography and the kind of fast-growing tree in dry climates that can function well as a host plant secondary and can also be used as a shade tree for early plant sandalwood explains that although almost all types of plants can be diparasitikan by the roots of sandalwood, but not all plants are hosts for which to plant sandalwood [28,8]. Effectiveness of parasitism sandalwood are low even though many haustoria formed, proven to cause the growth of sandalwood increasingly depressed [7]. Spacing is one factor to consider in the treatment of a plant cultivation. The growth of sandalwood seedlings in pots (polybag) is determined by the spacing of the host of the parent plant sandalwood dipolybag 5 cm provides good growth results [49,50]. Furthermore, provides a measure of polybag best is 15 cm x 25 cm [44], while uses the size of the bag polybag 18 x 30 cm with a spacing of 30 cm from the parent plant sandalwood in the nursery and planting distance of 40 cm from the plants master in the field [39].

The growth of a plant sandalwood is also determined by the type of soil and subject to the soil-forming parent material. Nutrients taken by the host plant sandalwood will vary depending on the type of soil both on land and soil entisols latosol [14]. Differences in the intake of nutrients or nutrients taken up by the host will affect the contribution of these nutrients to plants Sandalwood both in the nursery and the planting site. Therefore, it becomes interesting to study more in depth through a study of the role of host legumes and non-legumes as hosts for plant growth sandalwood, and its effects on soil type [22].

2. Literaure review

2.1 Sandalwood Plants

2.1.1 Type sandalwood

Sandalwood is also known by several local names such as ai-Kameli or known ai-meligi (Timor Leste), East indian sandalwood, White sandalwood, Yelow sandalwood (England), Bois santal (France), Sandalwood (Indonesia) [14]. This sandal type is a type that grows the majority of the island of Timor in general. According

to people on the island of Timor, there are two kinds of sandalwood seen from sandalwood leafy leaf size is fine with the small size and large-leaved. The classifying of the sandalwood into two groups: small-leaved sandalwood with the scientific name (*Santalum album*, Var) and a big leaf sandalwood (*Santalum album*, Largifolium) [48]. Sandalwood an upright trees whose height can reach 12-15 meters, the wood is white or yellowish and fragrant leaves, the leaves are oblong to oval and small with small flowers were originally white-brown but later changed to red blood and pieces of fruit in the form of a single, small and black when ripe [29]. Sandalwood experienced rapid growth during the first 20 years and after that the growth rate of fixed diameter and will not stop until the age of 100 years [20]. Wood porch began to form at the age of 15 years concurrently on the development of the stem, root and branch, followed by the formation of the twigs or branches that are smaller and to get the wooden porch that better logging should be done in the age over 50 years [27].

The characteristics of the sandalwood tree is a tree of small to medium can reach 20 m and a trunk diameter of 40 cm and can be deciduous, canopy shape slim to widen and shape of round rods and branching somewhat squiggly, systems rooting riding with long branches roots can reach several meters and if it is broken can form buds, ripe fruit, dark brown with a size of 5x3 mm. In the process of cultivation of sandalwood, good breeding among other seeds planted in the capture of the selected seed sources or good quality seed [34]. Soil type also affects the growth of sandalwood. The important factor to consider in selecting a host is to consider the suitability of the host to the soil and climatic conditions somewhere. There are also several suitable host for sandalwood in sustaining such growth better sandalwood and *Acacia acuminata, Allocasuarina huegeliana, Acacia aneura, Araucaria acuminata* is the best host for sandalwood accompany up to the age of 15-30 years and are able to survive on a variety of soil conditions with low rainfall of 400-600 mm [13]. Treatment of seedlings at the beginning of the nursery have also been carried out by the method of soaking the seeds before seeding. Furthermore, the difference in treatment growing medium with a ratio or a ratio of 1: 1: 1 with the composition of the medium is sand: soil: compost and 10 repetitions with polybag bag size 18 x 30 cm with a number that doubled as a host on the same type [39]. Planting done crossed the polybag will affect the growth of sandalwood up to 10-12 cm. Sandalwood plants including plant species arid areas and not stand by excess water [15]. Maintenance of sandalwood seedlings are very important to get good quality seed selection is done one month before the move on the ground, to get the seeds that withstand relatively high temperatures and drought stress in the field [29]. Criteria for the good seed is the age of eight months, is shown by the woody stem bark brown color, this is due to the quality of seeds and seedlings affect the growth of crops in the field. The older age of sandalwood seedlings, the growth is getting better [45]. However, the use of eight-month-old seedlings which reached a height of 20 to 40 cm and a diameter of rod 0:30 until 0:50 cm results have been good enough to be planted in the field and at the age of only 60% of the seed which meets the requirements to achieve the quality of the seedlings. Conditions such as these seeds are relatively resistant to high temperatures and drought conditions in the field [44].

The sandalwood seed quality depends on the quality of seed obtained from the mother tree in addition to environmental factors and genetic variations will also affect early seedling growth [46]. Derived from the seed source of stands older than twenty years instead of individuals living alone or a cross in. To know the mature trees can be determined by pig drill as deep as 2.5 cm. Efforts to improve the seed source is done by planting an area with a diversity of sources of seed more than twenty-five types. Handling in the nursery are more sensitive

adapted to the properties of natural sandalwood growing medium used, the size of polybags, type and amount of fertilizer, time and frequency of watering, presentation shade, weeding and age of seedlings to survive in a field that is at least eight months and is hosted to more than three hundred species of plants, and each of these host plants provide different advantages [44]. The more the host at the sandalwood it will be better the growth of sandalwood because it has the function of helping to absorb nutrients such as Nitrogen, Phosphorus and Amino Acids, historian or nodule of the root to the roots of sandalwood and historian 70% formed after 30 days sprouts and 97% after one year. This is proved by the treatment of four varieties of different host such kind Acacia (*Acacia acuminata, Acacia saligna, Acacia and Acacia microbotrya hemiteles*) is a potential for the growth of sandalwood. At the seedling stage give a percentage to grow to 81-94%. Sandalwood seed that has germinated and grown together with the planting of the primary host *Alternathera sp, Deamanthus firgatus* and *Clotalaria juncea* provide the best growth sandalwood seedlings in nursery and field. Sandalwood secondary host plants already known to the public as turi, trembesi, kaliandra, kabesak, johar, nangka, casuarina, gmelina, turi, timau, jambu, villosa and flamboyan. but keep in mind that the host plant does not become a competitor in the race for nutrients and light for sandalwood by planting only 6% of host plants in the field [8].

The nursery is a place to process the seeds into seedlings ready to be planted in the field that includes the determination of the nursery and the selection of temporary and permanent locations covering layout, water supply, soil conditions, living fences, road transport and slope and soil type. Variation or diversity polybag bag size also affects the growth process during the sandalwood seedlings still in the nursery [44]. The use of size plastic bag or polybag growing, with media mix for seedlings using topsoil upper or top soil and mixed with sand and compost with a ratio or a ratio of 4: 1: 1, and the type of plant primary host purslane (Alternanthera sp.) Are very affect the growth process both dimensions sandalwood plant height, stem diameter sandalwood, survival rate sandalwood, dry weight, and sandalwood seedlings quality index, as well as lowering the ratio of root shoots. Growth and quality of the best sandalwood seedlings produced using plastic bags the size of 15 cm x 25 cm the percentage of life can reach 92% [44]. Indeed, if the bag is a decent size and a good result for the host used is purslane or undergrowth and not be competition with sandalwood seedlings. Good quality sandalwood seeds are seeds that have a balanced growth between the top with the roots of plants commonly known as root and shoot ratio for each type of plant will have a ratio of root shoots different [44]. Based on data from the root shoot ratio shows that the larger the bag, the ratio of root shoots diminishing which means it will produce weight sandalwood seedlings root growth will be even greater. Extra volume size plastic bag that the greater the yield growth and better quality seeds. Growth and seed quality sandalwood most well occur in the use of plastic bags greatest is the size of 15 cm x 25 cm. This is because by using a larger plastic bag sandalwood roots of the seedlings are growing better, so we can conclude that the bigger polybag bag as a growth medium nursery sandalwood, the better percentage growth. More sunlight entered into seedlings in the nursery will also increase photosynthesis. Sandalwood is also a type of plant that needs light so that the growth should be enough sunlight [44]. Reduced sunlight leads to reduced photosynthesis and potential water will also decline in the canopy are getting lower so that the interaction between the volume of the container at a density of seedlings in the nursery will reduce seedling growth mainly on seeds that have a density Meeting (> 250 seedlings / m2) and seedling growth of sandalwood will vary when using container size variation, due to the influence of seed density and volume of growing media [44].

2.1.2 Ecosystem Sandalwood

Technically plant growth is strongly influenced by seed, since the treatment in the nursery, planting, maintenance and a place to grow in accordance with the conditions of land [8]. Differences in plant growth sandalwood on each pattern is also influenced by the interaction between the components of the plant. Positive interaction on the pattern combination of plants will result in increased production of all components of the existing plant on the pattern, but when the form of the interaction is negative then the increased production of one kind of plant would cause a decrease in the production of other plants [9]. Staple crops sandalwood obtain additional nutrients for the growth of the interaction of roots in the soil [33]. Quality seeds *Santalum album* influenced by good growth media, where the plant roots grow and develop. *Santalum album* seedlings grown in organic media have a relative quality index value equal to the soil media boss. A lack of nutrients in the soil may occur because of natural fertility is low, or because of the magnitude of the loss of nutrients in the soil. Loss of nutrients can occur because the washing process (*leaching*) is too high, evaporation and can even occur due to excessive use by certain plants in the pattern. Furthermore, according the selection of farm commodities in particular land, land suitability classes should be considered [33]. Data distribution of rainfall, for example, need to know to plan your time and cropping patterns, data on the number and intensity of rain is necessary to select conservation technologies [48]. The relationship of soil and site conditions with sandalwood roots mechanisms will vary according to conditions where the growth can be explained as follows [8]:

1. If grown in the open or exposed to the sun all day or light, then the tree canopies rarely or not the meeting and only reached a maximum height of 12 m. In the dry season the leaves are rarely or almost no leaves, with green leaf color is up to yellow.
2. If it grows in the shade of other trees that weight, the height of the tree can reach 15-18 m with a circumference of about 2.4 m, larger and thicker leaves with green older than the trees growing in the open.
3. Sandalwood can be grown in areas which height 50-1200 m above sea level, but is generally more sandalwood plants were found at an altitude of 400-800 m above sea level. Sandalwood plants can grow better in soil, volcanic soil that is loose and rocky from the nutrient-poor soil.

The process is closely related to plant growth and cell division process of forming new plants that eventually form the structure of a plant canopy. New cells are formed from amino acids resulting from the process of photosynthesis in the leaves of the plant organ [28]. Furthermore states that the production of biomass crops including economically valuable parts or parts that are harvested composed mostly of the result of photosynthesis. Photosynthesis is a natural process the only one known to alter the inorganic material into organic matter [28]. Usefulness of carbohydrates in plant growth not only as the building blocks of the body structure of the plant, but also as a source of energy metabolism is the energy used to synthesize and maintain the plant biomass and a large or small size of the header is used to estimate the magnitude of the rate of photosynthesis and respiration in plants , Plants sandalwood with a great header that has the possibility of greater photosynthetic rate of the plant sandalwood with a smaller canopy [36]. Leaves or the tree canopy is the main organ in the process of photosynthesis in trees. The outer surface of leaves are broad and flat allowing for light capture as much as possible per unit volume [14].

2.1.3 Process Parasitism Root Sandalwood

Sandalwood parasitism occurs through contact with host roots. This parasitism morphology can be seen from the point of connection of the roots. The contact begins with the formation Haustorium growing on root hairs sandalwood. Haustoria is a modification of sandalwood roots attached to the roots of the host plant is used as a tool to absorb nutrients from the host plant. After the root contact occurs then the nutrients from the roots of the host will flow to the root of sandalwood, thus the host will function optimally for sandalwood. Activity of hosts in supporting the growth of sandalwood is highly dependent on the level of sandalwood paratisme so that the effect of host plants on the growth of sandalwood different [33].

At the high-level paratisme sandalwood plants, the growth of the host will decrease which in turn causes disruption of the growth of sandalwood and over time will die [22]. It is further mentioned [8] that mature sandalwood Haustoria on a pyramid-shaped, while the young plants spherical yellowish green. As it has been explained that the plant sandalwood is hemiparasit and parasitism on sandalwood process underway through the roots [21]. In addition to the process of parasitism, the sandalwood plant life there is also competition or rivalry with their host plants. Most literature says that parasitism is a separate competition. But the fact that occur in plants sandalwood is not the case. In the process of parasitism sandalwood there is a gradual transition from a parasitic to competition [51]. Sandalwood benefited from the presence of other plants or from its host plant, but sandalwood have to compete for water, nutrients and light before the process of parasitism occurs. Several studies have been conducted to understand their interactions. Based on the conventional sense, the root is a root parasite on duty "robbed" of water and nutrients from its host. But in reality, the roots of sandalwood not just "robbed" of water and nutrients, but "take over" or "master" the roots of the host plant. Furthermore, the roots of the host sending the full charge of water and nutrients to the roots of sandalwood. Stages of this development process schematically as follows:

1. Root sandalwood with the roots of the host plant still independent, so at this stage be competition for water and nutrients
2. The roots of sandalwood has been attached to the roots of its host and formed Haustoria. In this phase, sandalwood has started to take on water and nutrients from the roots of its host
3. The roots of sandalwood has "mastered" the roots of the host. In this phase, it can be said that there has been a process full parasitism, because all the water and nutrients that are absorbed from the soil by the roots of host fully flowing to the roots of sandalwood [8].

Based on the survey results at the root of sandalwood in the province, it turns out the percentage of contact with the roots of host sandalwood roots are relatively small compared with the total roots of the host plant and artifacts are two things that need to be studied (Wawo, 2002), namely:

1. Parasitizes sandalwood does not occur in the type of large woody roots and thick,
2. After the process parasitizes by sandalwood, the water and nutrients from the host diverted to sandalwood, the growth of fine roots of host plants is limited.
3. In addition, the roots of host parasitizes not have thickening of the roots, because there is no good

energy shipments from the host plant itself or from plant sandalwood.

The types of parasitic plants develop and adapt to modify the way the roots by forming Haustoria when it comes in contact with the roots of host plants. Contacts occurring form a link between the sandalwood with its host plant both anatomically, morphologically and physiologically, so that the presence of these contacts made possible the flow of water and nutrients from host plants to parasites [16]. The roots of the host role has the task of sending full of water and nutrients to sandalwood [39]. Stages of this process of development, divided into three situations are:

1. The competition situation, occurs when the root of a host of sandalwood and still be independent, so that in this phase are equally compete for water and nutrients. This situation lasted ± 3 months and not all the same host species.
2. The situation of transition, which is the root of sandalwood has been attached to the host and formed Haustoria. This situation allows sandalwood benefit greatly from the interaction between host and parasite. That advantage as originally sandalwood can suppress the negative effects of competition so as to increase further in line with a growing, and increasing the effectiveness of root parasitism, then the benefits will be much greater when compared with conditions that are planted in monoculture. Situation good transition to the parasitism of sandalwood on its host.
3. Situation full parasitism occurs when the root of sandalwood has diserapi from the ground. This situation resulted in the loss of function of the host plant because it has been dominated by sandalwood roots. In this situation the effectiveness of parasitism sandalwood if high, then the host grows very weak or even die because there is not the translocation of water and nutrients from the roots.

The key point in understanding the parasitism is that we must know how many roots of host plants are grown per volume of soil diparasit by sandalwood, where the roots may serve the needs of water and plant nutrients sandalwood. This parameter is hereinafter referred to as "effectiveness", which is a parameter that indicates the number of host plant roots that are "owned" by root parasites per unit sandalwood sandalwood total root length of the lining and the same soil zone. Because the host plant will die, so there is no delivery of water and nutrients again. Therefore, the ability of plants to absorb nutrients from the soil through the roots known as "nutrient foraging" is influenced by three ways:

1. Changing the geometry of the root, which is associated with the root diameter, and root elongation.
2. Change the ability to use ions in the soil.

Form associations with other organisms are able to provide a supply of nutrients.

Sandalwood less respond to fertilizer Nitrogen and Phosphorus [47]. NP fertilization is unable to stimulate seedling growth of sandalwood and indicate that the ability to absorb nutrients NPK very low [33].

2.2 Host Legume

Legume plants have the advantage of nature: the ability to supply N or nitrogen fixation which is good because this plant is hosted by nitrogen fixing bacteria. Therefore legume plants are often used as green manure, as well as the leaves that fall into the source of organic fertilizer N levels high, it is also possible donation of land by the nitrogen permeation root nodules. In regard to the cultivation of sandalwood, legume plants are very advantageous for use as a host because in addition to its ability to supply nitrogen, is a chronic plants that are hosts remain, is also a source of organic fertilizer for the surrounding environment [42]. Most Angiospermae which hemiparasit root has a level keparasitan varied and attack haustoria root sandalwood influenced by its compatibility with the nature of the roots of the host, the physical condition of soil, drainage, the level of violence root and water content of the roots of the host plan [2] and the suitability of the depth of the roots with root sandalwood [43]. Sandalwood showed real ability selective in choosing a host as a form of parasitism association, sandalwood roots success attacking the roots of host plants of the fit between the nature of sandalwood with the host. Besides suitability nature and depth of the root system, the interaction between plants is also determined by the biochemical properties and the suitability of each plant produces certain chemicals that determine the nature of its interaction with other plants [31]. Some woody legume plant species (perennial) has always had towards other plant residues, among others Eucaliptus, Gleresidea, Leucaena and Albizia. Legume plants is huge potential as an organic fertilizer for their ability to bind atmospheric N2 is symbiotic with root nodule bacteria (Rhizobium). In the early stages of the host, use the nodule bacteria 30-50% nitrogen difiksasinya. Being the next stage, nodules will give 80-90% nitrogen fiksasinya results to the host. Further said that the element N is a macro elements that are essential to support the vegetative growth of plants. Nitrogen as the building blocks of proteins, enzymes and chlorophyll a very vital role in a wide range of activities of plant physiology [47].

2.2.1 Plants Turi

Sandalwood seedlings with turi host live better than the seedlings without a host, and that Nytrogen and Phosphor 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 effectively [47]. Root absorption capability associated with the level of development of the roots, such as root biomass, branching intensity, the intensity of root hairs and root cortex tissue anatomical structures. Generally, plants increase the ability to absorb nutrients produce dense root system, and it is not owned by the sandalwood to form roots more in control by genetic factors rather than environmental factors, although environmental factors also affect the results of the formation of roots. Turi is a small trunked tree whose height reaches 10 meters. The shape of a tree with sparse branching, horizontal branches, erect main stem, canopy tends to rise, double pinnate leaves. The flowers are arranged compound, white crown, the type of butterfly-shaped pods and hang with the special nature of plant turi is growing so fast. Turi can adapt to the acidic soil that is infertile, sometimes also thrives in waterlogged soil. The leaves and flowers can be made of vegetables. Turi stem bark have medicinal properties colitis, drug canker sores and scabies medicine. Turi plant can also be used as roadside trees or yard.

2.2.2 Plants Kacang Gude

The raising of hosts should be done early in order to have them ready for pricking out together with Sandalwood

germinants. Appropriate hosts include: *Cajanus cajan, Sesbania species* " [21]. Gude beans can meet the requirements provide an advantage in terms of adaptation compared to other kekacangan plant, which is tolerant to drought and can diratun [3]. The growing process is very suitable for various types of soil, both on fertile soils, acid soils, and soil salinity and high alkaline acid. This species also grows in tropical and subtropical regions, in the lowlands to an altitude of 2000 m, resistant to high rainfall intensity. Pigenon pea resistant bean pods fall and not easily broken [46]. In order to introduce, develop, and improve peanut production Gude monoculture in the area of dry land area, it is necessary the development of cultivation techniques well as setting a population of plants (plant spacing), planting improved varieties, the use of agricultural waste as mulch, and fertilizer [38]. Gude beans includes beans which are legumes. Gude pea plant mainly cultivated in tropical and subtropical regions such as India, Africa, Southeast Asia, the Caribbean, Fiji and Australia, especially in dry climates [9].

2.3 Host Non Legumes

2.3.1 Plant Alternanthera sp. (Purslane)

There are 275 types of purslane (Alternanthera sp) around the world [35]. This plant is known as purslane (Alternanthera sp) has the characteristics of plant height of 10-15 cm growing form dense clumps and spread to the side with many branches [33]. The leaves are heart-shaped with a wide variety of colors include red, green, and some are green patches of yellow. The flowers are small, white, single or in pairs emerging from the tip of the stem or branches. These plants can be grown in mountainous areas and can also be grown in lowland areas. Purslane plants (Alternanthera sp) have fibrous roots, which many water so that it can survive in dry areas [33]. Purslane plants (Alternanthera sp) growing merumpun it is often planted at the borders of the road and sometimes planted on the lands that are slightly tilted to prevent erosion [35].

2.3.2 Plants Casuarina junghuniana

This evergreen includes about 70 varieties of plants including Indomalaysia, Australia, and specific islands. Casuarinaceae has branches monopodial and ortotropik [33]. Mountain fir grown in the highlands at an altitude of up to 3,000 m above sea level. Likewise that the effect of nutrients from the host pine sandalwood will give the best results in the growth of sandalwood. Effect of N, P, K, there are also other micro elements such as Zn, Mn, Cu that support the growth process of sandalwood. Therefore Sandalwood grow better when planted among the pine mountains or in the woods compared to the open [5]. Some species such as Casuarina equisetifolia evergreen, fast-growing tree species in dry climates that can function both as a secondary host plants and can also be used as an initial shade plant sandalwood [28]. Sandalwood young plants like shade, while the secondary host of newly planted in the ground were not functioning well as a shade tree and the host. The shade plants sandalwood with sarlon until the age of one year with irradiation intensity of less than 50% could increase the percent of growing crops and after the age of one year percent growth decreased [12]. The stated of nursery of tree that at the beginning of the planting sandalwood plants are very sensitive to drought and will soon die by long exposure to direct sun [5].

2.4 Types of Soil in Support of Growth Sandalwood.

Soil is the surface layer of the earth that came from rocks that have undergone a series of weathering by natural forces, thus forming regolit or a layer of fine particles. Land is also a layer of the earth's surface that physically serves as a place of growth and development of roots supporting upright growth of plants and supply the needs of water and air, chemically serves as a warehouse and a supply of nutrients or nutrients in the form of organic and inorganic compounds is simple and essential elements such as N, P, K, Ca, Mg, S, Cu, Zn, Fe, Mn, B, Cl and biological function as a habitat for organisms to organisms that participate actively in the provision of nutrient and chemical additives to spur pertubuhan, and protect plant, which is capable of supporting three integral productivity of the land to produce biomass and production of a crop [19].

3. Types of Soil Litosol

In East Timor, the lands that include fertile largely cultivated population. Lands undeveloped land generally live less well known marginal soils [19]. Upland soils are generally composed of ground ultisol or commonly known as red-yellow podzolic and possibly oksisol. Soil texture sandy soil and iodized high is the type of soil that dominates the land in East Timor. Based on the information produced by the East Timor soil map, that this region has a type nutrient-poor soil condition, thin, direct contact with the rock or referred to litosol. From the information obtained from the soil map of the study area consists of two land classification including soil type and entisols litosol. Each soil type is identified based on the features and characteristics of the land. Land litosol this there are areas of the undulating, hilly, parent material variety, is a land that is still raw, the ground is still very shallow, texture loam, crumb structure, consistency of loose, permeability slow, good drainage, resistance to erosion is low, pH ranges 5.0 to 6.5. In the process of the growth of a plant the most important thing is how the crop is able to absorb nutrients from the soil to transfer to all parts of the body such tanaan. Good quality soil means the land has high capability in increasing the productivity of land and have high resistance to the effects of land degradation [32]. To produce good growth of sandalwood is needed fertile soil, nest, well drained, alkaline soil reaction in the thin soil solum. In general, sandalwood grows in the parent rock of calcareous-volcanic, shallow soil is rocky, the texture of clay, soil pH neutral-alkaline, Kadar N being, P2O5 medium-high, color black soil, red-brown, the soil type is generally litosol, mediterranean and complex ground [17]. Sandalwood require elements Fe, Ca and K were high from the ground [30].

4. Types of Soil Entisol

The soil type entisols is developing new land. Nevertheless, this land is not only a source material or soil parent material alone but must have a process of soil formation which produces epipedon okhrik. Many Entisol land used for agriculture, for example in the area of regional stream sediment or coastal marshes. Paddy rice grown in these alluvial areas [19]. Entisols soil types cultivated for rice cultivation both technically and rainfed rice fields in the lowlands. This land has the consistency of loose-loose, lower aggregation level, are vulnerable to erosion and nutrient content tersediakan low. Potential soils derived from volcanic ash is rich in nutrients but not yet available, will be accelerated weathering activity when there are enough organic matter as a provider of organic acids (Tan, 1986). Entisol has a base saturation varied, the pH of acidic, neutral to alkaline, CEC also

vary well for 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 due to lower water levels and the possibility of oxidation better in coarse-textured soils also naturally from the addition of organic materials is less than the rest of the land is more subtle. Although there is no leaching of plant nutrients and relatively fertile, to obtain high-yield crops usually require fertilizer N, P and K [23]. Entisol can also be divided based on the great ungrouped, some of which are Hydraquent, Tropaquent and Fluvaquents. The third great group this is a suborder Aquent is Entisol that have material sulfidic at a depth ≤ 50 cm of the soil surface mineral or always saturated water and in all horizons below 25 cm there is a 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 [19].

5. Plant Spacing

The distance between the parent plant sandalwood can be done at a distance of 4-5 m with a range of host with the parent plant 40 cm but this depends on the type of soil [13]. We recommend planting a host of field at a spacing of one meter of distance sandalwood parent plant. But if planting is done in April then every 2-3 sandalwood seedlings can be planted host species with a distance of 40 cm from sandalwood. If the sandal has reached the age of 5 years, then the process will parasitisasi normal, if the comparison host by plant sandalwood is 1: 1, the host will be more pressure, but if the age of 2 years, the ratio is 1: 2 or 1: 3. Thus we can say that if it would take 400 seedlings sandalwood, the host is required to accompany sandalwood can reach 1000 host [13]. The growth of sandalwood seedlings in pots (polybag) is determined by the spacing of the host of the parent plant sandalwood dipolybag 5 cm provides good growth results [49]. *Desmanthus virgatus, Crotalaria juncea*, and Alternanthera sp. is a good host for sandalwood seedlings [12]. The acacia (*Acacia villosa*) is a type of primary host better than kaliandra (*Caliandra callothyrsus*) and local Turi (*Leucaena glauca)* [50]. Furthermore, also explained that after the seedlings sandalwood are in a polybag approximately for 3 months, then be selected to get the seeds are uniform and at the time of sandalwood seedlings already have 7-9 leaves. Planting sandalwood failure caused by several factors such as planting too deeply so that the roots rot and too shallow so vulnerable to drought, folded plant roots, the roots of the rock or tunnels, plastic bags are not off, seed quality is inadequate and too dense media. The success of planting sandalwood need to be supported by factors such as plant material such as seeds, cuttings and stump, grow to be appropriate, how appropriate planting, required host plant and minimize disturbance such as fire, wild cattle, theft, pests and diseases and conditions climate.

6. The Metode

6.1 Place and Research duration.

6.1.1 Side of Research

This research was conducted in Dili, Timor Leste and nursery housed in permanent locations MAFP-RDTL, Dili, Timor Leste. Total area for the location of the nursery in accordance with the concept of the study is 27 m2 obtained from the pot diameter (40 cm) x (342 experimental unit) wherein 270 experimental units for testing in the nursery. The trial in the nursery will be the demolition of the pot, which is overgrown seedlings sandalwood

to do measurements according to this parameter is specified on the concept of research (destruction) and 72 for the test group planting in the field that is the result of the best combination of treatments in the nursery (non-destructive).

6.1.2 Design of Experiments

This experiment was conducted in a nursery with a basic design of a randomized block design (RCBD) factorial two-factor and repeated three times, the first factor is the type of host plant and the second factor is the spacing. From both of these factors after the combination can be obtained 4 (host) x 3 (a spacing) x 3 (replicates) x 8 (observation) = 288 experimental unit where in each experimental unit were observed every 1 month on-site nursery for 6 months on 216 experimental units coupled with 72 experimental unit is the result of selection dipersemaian the best combination that will be moved to the planting site or field. Of each first observation to the last observation dipersemaian, would have taken four of the best experimental unit at any observations to be brought into the field to be planted on two types of soil. The remainder of the best combinations will be dismantled to be done to stem diameter measurements sandalwood, sandalwood plant height, leaf number and the number of plants sandalwood haustoria formed.

6. 1.3 Execution Trial

Media grow plants at the nursery is used a mixture of soil, sand and compost to volume ratio 6: 3: 3 and placed in a polybag 30 x 40 cm. Before the first seed planted sandalwood The sandalwood seeds dahuluh digerminasi or soaked with warm water 50^{o}C for 24 hours. Furthermore, the pot which has been filled with growing medium is placed on the ground at random, then each polybag planted seeds of sandalwood by one seed per hole in a poly bag and followed the planting of the host with a distance of sandalwood 5 cm, 10 cm, 15 cm has been prepared by dena trial in the nursery are presented in appendix 1 and group planting in the field is presented in appendix 2.

6.1.4 Design of Experiments

This experiment is a continuation of the first experiment with the basic design is a randomized block design (RCBD) only increased by one factor, namely the cluster planting. So that there are three factors and repeated three times, the first factor is the type of host plant and the second factor is a spacing and the third factor is a group planting. The number of units of the nursery trials under the best combination of selection results will be planted in the field on the ground litosol and entisols, as many as 72 experimental unit. From the results the best combination will be planted on soil type and entisols litosol by planting groups of type of legume and non-legume host.

7. Results and Conclussion

7.1 Results

After the collection of primary data through measurement and observation for approximately one year, starting

from July 2015 until August 2016 has shown results that can be accounted for. Data observations and measurements are grouped into three main sections namely destructive measurements to determine the number of Haustoria (sandalwood plant root nodules) in the nursery stage followed by measurement of the height and dameter as well as the number of leaves, the planting stage, and soil analysis phase. The measurement results can systematically be described as follows. Sandalwood seedlings were used in this study are sandalwood seedlings which have a uniform growth. After germination in the displacement plots sown seedlings in a polybag. Seedlings are removed or planted in polybags are seedlings which have leaves number two strands. A total of 3 sandalwood seedlings planted in polybags, and after the age of 2 weeks after planting thinning that left only one course of sandalwood seedlings in each polybag.

7.2 Research Introduction

Sandalwood seed began to germinate at the age of 21 days after sowing (DAS) and at age 25 HSS sandalwood seeds have germinated. Furthermore, the removal of sandalwood seeds already germinated into polybag provided. In polybags have grown legume host plant (Sesbania grandiflora, Cajanus cajan) and non legume namely (Althernantera sp, Casuarina junghuniana) were planted earlier. Each polybags each planted one plant sandalwood. Thus it can be said that there are approximately 80% distribution sandalwood seeds sown in the soil that grows on fourteen days after seeding. Sprouts which has had two strands of leaves moved into a polybag provided. Polybag will also be planted with a spacing suitable host and previous treatment. In the first month after the move, there are several sandalwood saplings were dead, and therefore do embroidery with the aim to replace dead plants with plants that grow healthy, fertile and the same age as crop research. During the study does not look visually differences between treatments were tested. Sandalwood seedlings have almost the same height. In addition, during the study there was no pests or diseases against sandalwood seedlings were tested.

8. Experiments in nurseries (Research I)

At the beginning of the planting sandalwood seedlings planted at the same age and appearance of the uniform, but with the increasing age of the plant the appearance of sandalwood also begin to diverge. In contrast to the host plant, the appearance is no different host plants showed despite increasing age of the plant. During his stay in the nursery, plant a lot of overgrown weeds, weeding is done by removing the existing grass, some host plants, especially Chromolaena odorata (kirinyu) affected mealybug pest resulting perming or rolled leaf shoots. Control is done manually by cutting the leaves of the affected pest.

8.1 Observations Destructive

These observations were made to determine how the number of Haustoria formed by the provision of host legume (*Sesbania gradfora, Cajanus cajan*) and non legume (*Alternanthera sp, Casuarina junghuniana*) at different spacing.

8.2 Number Haustoria (nodule / nodules per plant)

Calculation Haustoria done at the plant sandalwood with the treatment plant spacing and the host legumes (Sesbania gradfora, Cajanus cajan) and non legume (*Alternanthera sp, Casuarina junghuniana*) during the nursery or seedlings sandalwood aged 60 HSS 90 HSS, 120 HSS, 150 HSS and HSS 180. Plants that are in a polybag included in a bucket of water, and rocked slowly to the ground apart, after the land has been freed all together sandalwood plant host plants raised slowly and after that it can calculate the amount Haustoria. Results of analysis of variance (ANOVA) showed that the combination treatment spacing of 5 cm, 10 cm and 15 cm with a host plant legumes (Sesbania gradfora, Cajanus cajan) and non legume *(Alternanthera sp, Casuarina junghuniana*) significantly affected the number of Haustoria root seedlings sandalwood (attachment 10) when compared with the untreated host sandalwood plants and plant spacing. Results of analysis of variance at age 60 HSS can be explained that the number of Haustoria on seedlings sandalwood show interaction planting distance and the host was not significant (non significanta) on the formation of Haustoria plant sandalwood, but the variety of host legume (Sesbania gradfora, Cajanus cajan) and non legume (Alternanthera sp, Casuarina junghuniana) greatly affects the formation Haustoria at age 60 HSS. Host plants Non Legumes *(Alternanthera sp, Casuarina junghuniana)* significantly affected the number of houstoria that formed the roots of sandalwood on the roots of host plants sandalwood at age 60 HSS 90 HSS and 120 HSS, number of leaves seedlings sandalwood at the age of 60 HSS 90 HSS and 120 HSS and a trunk diameter of sandalwood seedlings at the age of 60 HSS 90 HSS and HSS 120.

Number of sandalwood seedlings root Haustoria more on sandalwood seedling roots with host plants Alternanthera sp (purslane) with a spacing of 5 centimeters (26.0 nodule) (J1AS1), 10 cm (28 per plant roots) (J2AS2), 15 cm (18 per plant roots) (J3AS3) sandalwood seedling roots with host plants junghuniana Casuarina (pine) with a spacing of 5 centimeters (22.0 nodule) (J1CJ1), 10 cm (20 per root crops) (J2AS2), 15 cm (14 per plant roots) (J3AS3), sandalwood seedlings with roots of host plants (turi) with a spacing of 5 centimeters (23.0 nodule) (J1SG1), 10 cm (22 per plant roots) (J2SG3), 15 cm (18 per plant roots) (J3SG2). The number of stomata leaf sandalwood seedlings more on sandalwood seedlings with host plants purslane with a spacing of 5 centimeters (28.0 nodule) (J1AS1), 10 cm (28 per plant roots) (J2AS3), 15 cm (18 per root crops) (J3AS2) and sandalwood seedlings with evergreen host plants with a spacing of 5 centimeters (26.0 nodule) (J1CJ1), 10 cm (28 per plant roots) (J2CJ3), 15 cm (18 per plant roots) (J3CJ2), sandalwood seedlings with host plants turi with a spacing of 5 centimeters (26.0 nodule) (J1SG1), 10 cm (28 per plant roots) (J2SG3), 15 cm (18 per plant roots) (J3SG2) and sandalwood seedlings to plant tunis host with a spacing of 5 centimeters (26.0 nodule) (J1CC1), 10 cm (28 per plant roots) (J2CC3), 15 cm (18 per plant roots) (J3CC2).

Further test results BNT 5% of the average number of seeds Haustoria sandalwood from application of the host plant legume and non-legume (Alternanthera sp, Casuarina junghuniana) at different planting distances are presented in appendix 10. The test results further BNT 5% in Table 5.1 show that the administration of the host plant non legume (*Alternanthera sp, Casuarina junghuniana*) at a spacing of different had the number Haustoria the highest of four, and significantly different from the treatment of host legume who coined the amount Haustoria 2 at the age 60 HSS. This is because the increase in the number Haustoria hosts given are within optimal enough so that nutrients are absorbed by plants can increase the translocation fotosintat for root growth as well as for the establishment houstoria sandalwood sandalwood roots to form Haustoria.

Table 1: Influence of host and spacing of the growth Haustoria sandalwood plants at the age of 180 HSS

Host		Plant Distance		
		5 cm	10 cm	15 cm
Non Legume	Alternanthera sp	7.00a	6.33b	7.00a
	Casuarina junghunian	5.33b	5.33c	5.00b
Legume	Cajanus cajan	5.00b	7.00a	7.00a
	Sesbania grandiflora	4.00c	4.00d	5.33c
Control	Santalum album	0.00d	0.00e	0.00d

Basically that sandalwood will not grow if unaccompanied host, and if the roots of sandalwood not have Haustoria then growth will languish who will ultimately cause death. Although life but only last up to two years and after that the leaves will turn yellow and eventually die. Giving the host plant legumes (Sesbania grandiflora, Cajanus cajan) and non legume (Alternanthera sp, Casuarina junghuniana) at a spacing of 5 cm, 10 cm and 15 cm have a number Haustoria highest at age 180 HSS is significantly different from treatment non-legume host at a spacing of 10 cm. Increasing the number of Haustoria because hosts given are within a fairly optimal so that nutrients are absorbed by plants, can enhance the translocation fotosintat for root growth Sandalwood or for the formation of haustoria roots of sandalwood to form Haustoria, fotosintat are translocated to the roots also used to produce energy, and the energy produced will be used also for the absorption of nutrients from the plant. In the treatment without the host, there is no formation Haustoria therefore no fotosintat activity so that the process of photosynthesis decreases so that it can not improve translocated to form Haustoria. Total Haustoria to treatment with the legume host at a spacing of 5 cm treatment had no significant with host legume with a spacing of 10 cm, but in contrast to the treatment of non-legume at a spacing of 10 cm that has a number Haustoria more. This is presumably because the distance given is very close and is not suitable for an adult to accompany sandalwood field that suppress respiration of roots of seedlings sandalwood thereby forming plant's ability Haustoria very little.

9. Observations non destructive

9.1 High sandalwood plants in the nursery

Added sandalwood plant height is done by observing the sandalwood plant height were measured at age 60 HSS 90 HSS, HSS 120, 150 and 180 HSS HSS. Sandalwood plant height measurement starts from the base of the stem to the point sandalwood sandalwood growing crops, using meters. Results of analysis of variance (ANOVA) showed that a spacing did not affect plant height growth of seedlings sandalwood (Attachment 12). While treatment plant host legume Sesbania grandiflora and Cajanus cajan not significantly affect plant growth seedling Sandalwood. This is because the growth of plant species Legume Sesbania grandiflora and Cajanus cajan very fast compared to the parent plant Sandalwood. Therefore pertumhuhan Sandalwood be hampered due to the shade of the legume Sesbania grandiflora and Cajanus cajan excessive. Growth is a process towards

maturity. At 30 HSS high growth rate has not been so visible sandalwood plants gradually, good height, diameter but appears at the age of 60 HSS. Results DMRT has provided a summary that treatment of non-legume host (Alternanthera sp) greatly affects the growth process plant height sandalwood, followed by the type of Casuarina junghuniana well in the first month and for the continuation of the process prtumbuhan until planting in the field. Based on annex table 11 shows that at the age of 60 HSS, high seedlings sandalwood sandalwood seedlings were higher in the treatment of non-legume host plants (Alternanthera sp and Casuarina junghuniana). At the age of 60 HSS high sandalwood seedlings only influenced by the host but different spacing did not affect plant height sandalwood. While that is not significantly different from sandalwood seedlings with the treatment of a host plant Sesbania grandiflora and Cajanus cajan. As the plant parasites, sandalwood plant growth is highly dependent on its host plant. Based on this it shows that the treatment with a spacing of 5 cm and 10 cm, the host legume and non-legume seedlings sandalwood gained more nutrients and water for growth compared with a spacing of 15 cm. Increased acquisition of nutrients and water from the host plant the activity of apical cell division becomes more active thus spurring higher accretion sandalwood seedlings. Sandalwood plant growth would have been better if the host or a combination of host plants of nutrients and water contribute more to plant sandalwood. At the age of 90 HSS high sandalwood seedlings influenced by host and plant spacing. Non-legume host species affects plant height sandalwood at a spacing of 5 cm with an average of 24.48 cm high followed by a distance of 10 cm with an average value of 22.8 cm high and 15 cm with an average height niali 21.90 cm , Values on the type of non-legume host the purslane is no different with non-legume host species for junghuniana Casuarina (pine). The range of values each at a spacing of 5 cm high with 20:57 cm followed by a distance of 10 cm high with 21:47 cm followed by a distance of 15 cm high with 21:40 cm. Legume host type to the type of Cajanus cajan have a significant effect on plant height pertumbbuhan sandalwood at a distance of 5 cm with 22:57 cm high and 10 cm with a height of 18.90 cm and 15 cm with a height of 19:37 cm. While the host species for this type of legume Sesbania grandiflora has a height of 19.97 cm at a distance of 5 cm followed by 10 cm high plant with sandalwood 18:57 cm then 15 cm with a height of 18.97 cm sandalwood plants. While that is not significantly different from the high sandal with the treatment of a host plant Sesbania grandiflora and Cajanus cajan at a spacing of 5 cm with an average at the age of 90 HSS has a height of 19.97 cm and 10 cm with an average height of sandalwood 18:57 cm and a spacing of 15 12:23 cm cm tall. Average improvement in plant height sandalwood (Santalum album) at the age of 150 HSS as a result of the treatment plant spacing different (5 cm, 10 cm and 15 cm) with the type of host legume (Sesbania grandiflora, Cajanus cajan) and non legume (Alternanthera sp, Casuarina junghuniana) can be seen in table 5.6 below.

As the plant parasites, sandalwood plant growth is highly dependent on its host plant nursery or hinga good start planting sandalwood speedy way of life depends on the primary and secondary host. Based on this it shows that the treatment with a spacing of 5 cm and 10 cm, the host legume and non-legume, the more sandalwood seedlings obtain nutrients and water for growth compared with a spacing of 15 cm. Increased acquisition of nutrients and water from the host plant the activity of apical cell division becomes more active thus spurring higher accretion sandalwood seedlings. Sandalwood plant growth would have been better if the host or a combination of host plants of nutrients and water contribute more to plant sandalwood. The rate of growth will be slower sandalwood or obstructed in line with the little contribution of nutrients and water from the host plant. This of course depends on how many Haustoria formed by the roots and root iang sandalwood, so the absorption

of nutrients and minerals from the soil and the host can provide the maximum contribution to the parent plant sandalwood.

Table 2: The influence of the host against the growth of sandalwood seedling height at age 150 HSS

Host		Plant Distance		
		5 cm	10 cm	15 cm
Non Legume	Alternanthera sp	40.71a	0.99a	38.13a
	Casuarina junghunian	38.80b	0.98a	35.60b
Legume	Cajanus cajan	36.80bc	0.99a	37.63bc
	Sesbania grandiflora	36.20c	0.98a	35.20c
Control	Santalum album	13.35	0.67b	14.23d

Table 3: Influence of host plant on the growth of sandalwood seedling height at age 180 HSS

Host		Plant Distance		
		5 cm	10 cm	15 cm
Non Legume	Alternanthera sp	48.94a	46.74a	46.36a
	Casuarina junghunian	47.03a	43.36b	43.83b
Legume	Cajanus cajan	45.03b	45.93bc	45.86bc
	Sesbania grandiflora	44.43b	43.03c	43.43c
Control	Santalum album	14.35c	14.98d	15.23d

As noted in the early part of that growth is a process towards maturity that will not be back to normal. Iang high variation due to treatment and a spacing at the age of 150 HSS is very different from the age of 120 HSS and earlier age. At the age of 150 HSS, high sandalwood seedlings are not affected by the host plant (see appendix 14, 16 and 18). Nutrients and water that can be donated from the host plant 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 nutrient that can be absorbed by the host plant is widely used for its own metabolic activities of the seedlings donated to sandalwood. At the age of 180 HSS, sandalwood seedlings absolute height is not affected by the host plant. Nutrients and water that can be donated from the host plant did not differ in height increment spur sandalwood seedlings. It dapt described with increasing age of both sandalwood and host plants, the need for nutrients and water, grew in number and used for its own metabolic activities of the

seedlings donated to sandalwood.

9.2 The number of leaves (leaf)

Observations in the number of leaves is done by counting the number of leaves unfolded. These observations were made after the first two leaves grow until the end of months of observation. Results of analysis of variance (ANOVA) showed that the treatment plant host sandalwood with legume and non-legume effect no significant effect on the number of leaves of seedlings sandalwood at the age of 60 HSS, number of leaves seedlings sandalwood at the age of 90 HSS and leaves seedlings sandalwood at the age of 120 HSS, 150 HSS and 180 HSS. The average number of leaf sandalwood seedlings at the age of 60 HSS 90 HSS and HSS 120, 150 HSS, HSS 180 can be seen in Table 5.8 below.

Table 4: Effect of plant spacing and to increase the number of host plant leaves sandalwood at the age of 90 HSS

Host		Plant Distance		
		5 cm	10 cm	15 cm
Non Legume	Alternanthera sp	4.00a	4.00a	4.00a
	Casuarina junghunian	4.00b	4.00b	4.00b
Legume	Cajanus cajan	2.00bc	2.00c	2.00bc
	Sesbania grandiflora	2.00c	2.00c	2.00c
Control	Santalum album	0.00d	0.67d	2.00d

Description: Based on the analysis of variance, the effect of the interaction of the host plant spacing and meaningful tested. Values were followed by the same small letter in the vertical direction and the same capital letter horizontally do not differ by LSD at 5% tare.

Based on the results of analysis of variance to increase the number of leaf sandalwood seedlings from application of the host plant legume and non-legume on a different row spacing showed no significant difference in the number of leaves of the sandalwood seedlings at the age of 60 and 90 HSS HSS. Further test results BNT 5% as presented in Table 5.8 show that the provision of non-legume host plants treated with this type of purslane and fir with a spacing of 5 cm, 10 cm and 15 cm to increase the number of leaves in principle was not significantly different. The content of nutrients absorbed by sandalwood seedlings from the soil used to produce fotosintat. Fotosintat used for cell division activity in leaf chlorophyll. Besides being able to increase the activity of apical meristem cell division, resulting fotosintat can also increase the activity of the establishment and development of the primordial leaves. This led to a high increase sandalwood seedlings comparable with the number of leaves.

Table 5: Influence of host and spacing of planting to increase the amount of plant leaf sandalwood at the age of 180 HSS

Host		Plant Distance		
		5 cm	10 cm	15 cm
Non Legume	Alternanthera sp	16.00a	16.00a	16.00a
	Casuarina junghunian	14.00b	14.00b	14.00b
Legume	Cajanus cajan	12.00c	12.00c	12.00c
	Sesbania grandiflora	12.00c	12.00c	12.00c
Control	Santalum album	10.00d	10.67d	12.00d

It seems there is not significantly different from the number of leaves at the age of 120 HSS, HSS 150, 180 HSS, number of leaves, sandalwood seedlings were not affected by the treatment plant host legume and non-legume. This shows that the host plant legume and non-legume tested has the same effect on the formation of seedling leaf sandalwood. Variations in the number of leaves formed gradually predictable in any one month developmental growth in the number of shoots. The leaves are formed from primordial leaf development and this development only occurs because primordiaa leaf obtain fotosintat supply. Perananan host plants to support the growth of sandalwood sandalwood is that it helps plants to obtain nutrients and water. Nutrients and water available to plants and sandalwood from the host plant used for the metabolic activity such as photosynthesis activity. Although not all the nutrients and water and fotosintat produced by plants for the activity development of leaf primordia, but the lack of influence of the host plant that the number of leaves of seedlings sandalwood showed that the contribution of the host plant them in providing nutrients and water for plants sandalwood did not differ between the host plant and the distance planting is tested. Leaves can only be formed if the leaf primordia are formed during cell division apical meristem obtain fotosintat during its development. Fotosintat deficiency causes leaf primordia will not form a leaf. Increase the number of leaves of seedlings sandalwood in treatment spacing of 5 cm with host legume has a number of lower leaves of the plant spacing with host lgum at a spacing of 10 cm, this condition is suspected due to the treatment of legume with a spacing of 5 cm distance is too close, because sandalwood growth is covered by the host of excessive shade. This causes the activity of protein synthesis is inhibited so that it can also inhibit cell division by a lack of light the sun, including a cell in one of the three cells near the outer surface of the editorial aspects, some will primordial leaves become stunted. Activities unobstructed fotosintat will spur leaf primordial tissue becomes low so cell division, cell enlargement and cell differentiation also be low. This situation is expected as a result of the treatment plant spacing is too close, though Haustoria formed more and more, but causes the amount of absorption of water and nutrients is getting low. The low absorption of water and nutrients to reduce the activity open stomata and photosynthesis rate that will spur the lower leaf primordium network, so that cell division, cell enlargement, cell differentiation is running slow thus the amount of sandalwood seedlings leaves less and less.

9.3 Diameter

Added diameter rod by observing a trunk diameter measured at the age of 60 HSP, HSP 90, HSP 120, 150 and 180 HSP HSP. The shaft being measured is the base of the center. Stem diameter measurements made using calipers. Results of analysis of variance (ANOVA) showed that the treatment plant host sandalwood significant effect on stem diameter seedlings sandalwood at age 60 HSP, stem diameter seedlings sandalwood at the age of 90 HSP stem diameter of seedlings sandalwood at age 120 HSP with a spacing of 5 cm, 10 cm and 15 cm can be found in appendix 13. the average diameter rod sandalwood seedlings at the age of 60 HSS, HSS 90, 120 HSS, HSS 150, 150 and 180 HSS HSS and the results DMRT 5% can be seen in Table 5.10.

Table 6: Effect of plant spacing and host to the increase in diameter of sandalwood plants at the age of 60 HSS

Host		Plant Distance		
		5 cm	10 cm	15 cm
Non Legume	Alternanthera sp	0.05a	0.05a	0.06a
	Casuarina junghunian	0.04b	0.04b	0.04b
Legume	Cajanus cajan	0.03bc	0.03bc	0.03bc
	Sesbania grandiflora	0.03c	0.03c	0.03c
Control	Santalum album	0.02d	0.02d	0.02d

Based on Table 5:10 shows that the seedling stem diameter HSS sandalwood at age 60 did not differ on any host plant sandalwood from non-legume (Turi and tunis) with a distance of 5 cm but were significantly different at a spacing of 10 cm and 15 cm. At the age of 150 HSS and HSS 180 turned out to be significantly different at each treatment plant spacing. This shows that the host plant sandalwood or a combination of host plants with some spacing of having the same effect on seedling stem diameter sandalwood. For dicotyledonous plants, stem diameter enlargement or increase the size of the trunk diameter caused by the activity of the cambium cell division and enlargement or lateral meristem cells. Under these conditions, no differences in stem diameter sandalwood seedlings due to host plants and plant spacing to have the same effect on contributions fotosintat on cells in the cambium or lateral meristem cells of seedlings sandalwood. Under these conditions, the absence of sandalwood seedling stem diameter difference is because of the host plant both legume and non-legume has the same effect on contributions fotosintat on cells in the cambium or lateral meristem cells of seedlings sandalwood.

In contrast to the diameter of sandalwood at the age of 180 HSS very significant and significantly different at a spacing of 5 cm, 10 cm and 15 cm. Types of non-legume host very real berbengaruh of stem diameter sandalwood. Besides, photosynthetic activity is influenced by the amount of nutrients and water are absorbed by plants. The more nutrients and water that can be absorbed by plants more active photosynthetic activity and the more fotosintat generated. As a parasitic plant, water plant nutrient requirements and sandalwood is highly dependent on its host plant. Photosynthetic activity is influenced by the amount of nutrients and water are

absorbed by plants. The more nutrients and water that can be absorbed by plants more active photosynthetic activity and the more fotosintat generated. As a parasitic plant, water plant nutrient requirements and sandalwood is highly dependent on its host plant. Indirectly supply fotosintat for activity cell division and enlargement of the lateral meristem or cambium cells influenced by the host plant. There is no difference between a 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.

Table 9: Influence of host and spacing of the increase in diameter of the stem of the plant sandalwood at the age of 180 HSS

Host		Plant Distance		
		5 cm	10 cm	15 cm
Non Legume	Alternanthera sp	1.35a	1.36a	1.39a
	Casuarina junghunian	1.30b	1.30b	1.30b
Legume	Cajanus cajan	1.29c	1.29c	1.29c
	Sesbania grandiflora	1.29c	1.29c	1.29c
Control	Santalum album	0.98d	0.98d	0.97d

9.4 Planting Field Force Experiment

9.4.1 High sandalwood plants on soil type entisols

Results of analysis of variance (ANOVA) showed that the high growth of sandalwood plants on soil type entisols very different to the real growth of sandalwood on the type of soil tow litosol. It is the use of cluster planting dikarenaka factor against sandalwood plants will also impact the growth rate of sandalwood either on the cluster host plant with two, four or six host host to the treatment of legume and non-legume host. Spacing influencing the process of the sandalwood plant height pemrtumbuhan treatment plant spacing of 10 cm more pronounced in comparison with a spacing of 5 cm and 15 cm are in fact not significantly different. Besides the host plant legume Sesbania grandiflora and Cajanus cajan not significantly affect plant growth Sandalwood. This is because the growth of plant species Legume Sesbania grandiflora and Cajanus cajan very fast compared to the parent plant Sandalwood. Therefore pertumhuhan Sandalwood be hampered due to the shade of the legume Sesbania grandiflora and Cajanus cajan were brlebihan. Thus, in the nursery should be the type of legume Sesbania grandiflora and Cajanus cajan not recommended to be used as the primary host plant. But with this type of non-legume Alternanthera sp very significant effect on plant height at age 30 HSP sandalwood and no real effect on seedling height sandalwood Casuarina junghuniana treatment. Results of analysis of variance showed that the administration of the host plant legume and non-legume at a spacing different from planting different groups very significant effect on seedling height increment sandalwood.

The average results of measurements as height sandalwood seedlings showed that a high increment sandalwood

seedlings were higher in the group of planting two non-legume host at a spacing of 10 cm differ significantly different with increasing plant height compared with a spacing of 5 cm and 15 cm. This happens because there are organic compounds that have been formed by the plants that will be used for the process of cell division and enlargement of the apical meristems, which in turn provides a high accretion plant pretty good and optimal. The average height of sandalwood seedlings at the age of 30, HSP, HSP 60, HSP 90, HSP 120, 150 and 180 HSP HSP and the results DMRT 5% can be seen in Table 5.12 below.

Table 10: Influence of host, plant spacing, planting group and the type of soil on the growth of plant height sandalwood.

Soil type	Model Plant	Control		
		Santalum album (tanpa Host)		
		5 cm	10 cm	15 cm
Entisol	2	50.02c	50.19c	50.24a
	4	52.02b	52.19b	50.24a
	6	53.02a	53.19a	50.24a

Added high sandalwood seedlings on providing host plant legume and non-legume at different spacing of the group had no significant planting with legume treatment that has the lowest high gain 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. While on treatment with non-legume host significantly different from the treatment Alternanthera sp (purslane) and junghuniana Casuarina (pine), it is alleged in the treatment of purslane and fir given treatment will result in the protein synthesis activity pembelahana accelerate the process of cell division. At the beginning of the reduction in growth, followed also reduced the cell wall and protein synthesis within the network. Furthermore, translocation decreased cell division and the anatomically reduced fotosintat where old leaves dry out and fall resulting plants eventually die. Variations sandalwood measurement results against high dieffect by a variety of treatment used and the condition of the soil or different types of soil. SeCHAPTERa terkadnung nutrient content in the soil is not the same for any kind of soil and for each kondidi place. The level of diversity is also influenced by the type of host, plant spacing, and planting group that is used in different types of soil. It seems that high sandalwood plants to soil type entisols better than petumbuhan sandalwood planted on soil type litosol. The results showed that plant height entisols sandalwood on the ground with a spacing of 15 cm on the cluster planting 2 host seems to be higher compared with other spacing on soil conditions litosol with planting different groups. Based in annex 16 to annex 19 shows that at age 30, HSP, HSP 60, plant height sandalwood with the treatment of non-legume host more than in the treatment of legume host plants. While that is not significantly different from sandalwood seedlings with the treatment of a host plant Cajanus cajan. As the plant parasites, sandalwood plant growth is highly dependent on its host plant. Based on this show can be explained that the combination of host legume and non-legume with a spacing different from planting different groups on different soil types sandalwood seedlings more then obtain nutrients and water for growth. Increased acquisition of nutrients and water from the host plant the activity of apical cell division

becomes more active thus spurring higher accretion sandalwood seedlings. Sandalwood plant growth would have been better if the host or a combination of host plants of nutrients and water contribute more to plant sandalwood. The rate of growth will be slower sandalwood line with the little contribution of nutrients and water from the host plant. Likewise, at the age of 60 and 150 HSP HSP, high sandalwood that was not influenced by the host plant legume and non-legume. 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 nutrient that can be absorbed by the host plant is widely used for its own metabolic activities of the seedlings donated to sandalwood. At the time of high metabolic activity of the host plant, nutrients and water that can be donated to the plant host plantsn sandalwood amounts sidikit and this will affect plant growth next sandalwood.

10. Diameter

Results of analysis of variance showed that the administration of the host plant legume and non-legume at a spacing different from planting different groups very significant effect on the increase in diameter stems of seedlings sandalwood. Further test results BNT 5% of the average of the increase in diameter sandalwood seedlings from application of the host plant legume and non-legume at a spacing different from planting different groups are presented in appendix 20. The test results further BNT 5% based on the values listed in the annex 20 shows that administration of the host plant non legume at a spacing of 5 cm with a group planting 2 host legume have different accretion trunk diameter higher and significantly different from the administration of the host non-legume at a spacing of 5 cm. This can be explained due to the nutrients N and P contained in NPK fertilizers can be absorbed by plants so well that facilitate the absorption of water, nutrients and nutrients to the plant roots for the formation of amino acids that play a role in cell division meristem secondary that can cause the increase in diameter rod. The nutrition needed for high gain, increase the number of leaves, root growth, the growth of the branch, as well as to increase the size of the stem. Added diameter rod on legume treatment with two different host unreal with 4 treatment groups and 6 groups that have lower accretion trunk diameter of 2 treatment groups with non-legume host. Plant death is a process initiated by the reduction of the growth and leakage of cell walls topped by the roots so that the metabolic activity of the cells stopped thereby gain a trunk diameter of sandalwood is also low. The same thing happened on the treatment of host legume that has a trunk diameter less than the treatment of non-legume host, because the dose of host species legume Sesbania grandifora and Cajanus cajan given to plant sandalwood can not optimize the increase in diameter of the stem. So that the stem diameter sandalwood treatment of legume host smaller than the diameter of sandalwood seedlings on granting non-legume host. N elements required by the plant to form chlorophyll and protein. Therefore, the availability of chlorophyll, the photosynthetic process increases so the amount of carbohydrates produced increases. With the carbohydrates produced can affect the availability of nutrients in the body of the plant so as to improve the development of stem diameter. Results of analysis of variance (ANOVA) showed that the treatment of the host plant sandalwood effect no significant effect on stem diameter seedlings sandalwood at age 60 HSP, stem diameter seedlings sandalwood at the age of 90 HSP stem diameter of seedlings sandalwood at age 120 HSP. The average diameter of the trunk of sandalwood at age 30 DMRT HSP and the result of a 5% can be seen in Table 5.11 below.

Table 11: Influence of host, plant spacing, planting group and the type of soil on the growth of plants sandalwood diameter.

Soil Type	Model plant	Santalum album (control)		
		5 cm	10 cm	15 cm
Entisol	2	0.12b	0.17b	0.21a
	4	0.12b	0.17b	0.21a
	6	0.12b	0.18b	0.22a

This shows that the host plant legume and non-legume 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 10 cm more real sandalwood compared with a spacing of 5 cm and 15 cm. For dicotyledonous plants, stem diameter enlargement or increase the size of the trunk diameter caused by the activity of the cambium cell division and enlargement or lateral meristem cells. Activities cambium cells or lateral meristem cells in dicotyledonous plants due to these cells acquire fotosintat. Under these conditions, no difference due to the sandalwood stem diameter and spacing of the host plant or a combination of host plants have the same effect on contributions fotosintat on cells in the cambium or lateral meristem cells of seedlings sandalwood. Photosynthetic activity is influenced by the amount of nutrients and water are absorbed by plants. The more nutrients and water that can be absorbed by plants more active photosynthetic activity and the more fotosintat generated. As a parasitic plant, water plant nutrient requirements and sandalwood is highly dependent on its host plant. Indirectly supply fotosintat for activity cell division and enlargement of the lateral meristem or cambium cells influenced by the host plant. There is no difference between a 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. Based on the attachment 16 showed that stem diameter at the age of 180 HSP sandalwood different on each host plant seedlings sandalwood. This shows that the host plant sandalwood or a combination of host plants have the same effect on seedling stem diameter sandalwood. For dicotyledonous plants, stem diameter enlargement or increase the size of the trunk diameter caused by the activity of the cambium cell division and enlargement or lateral meristem cells. Activities cambium cells or lateral meristem cells in dicotyledonous plants due to these cells acquire fotosintat. Under these conditions, no differences in stem diameter sandalwood seedlings due to a combination of host or host plant has the same effect on contributions fotosintat on cells in the cambium or lateral meristem cells of seedlings sandalwood. Photosynthetic activity is influenced by the amount of nutrients and water are absorbed by plants. The more nutrients and water that can be absorbed by plants more active photosynthetic activity and the more fotosintat generated. As a parasitic plant, water plant nutrient requirements and sandalwood is highly dependent on its host plant.Indirectly supply fotosintat for activity cell division and enlargement of the lateral meristem or cambium cells influenced by the host plant. There is no difference between a 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.

11. Quality of soil on soil type and litosol entisols

In general, soil type entisols improve soil quality, either physical, chemical and soil nutrients. Improvement of soil quality parameters on soil type entisols associated with elevated levels of C-organic soil, which controls many important functions in the soil affects the quality and productivity of the soil [7,22]. The physical properties of the soil as the soil water content significantly increased by 29.80% compared with the type of soil litosol. Organic materials can encourage increase soil water binding and enhance the amount of water available for crop needs [16]. Organic materials are provided in the soil will undergo the process of weathering and reshuffle which in turn will produce humus [19]. Humus hydrophilic, therefore, humus can improve water absorption in the soil and also cause the water to be high storability. Humus can bind water four to six times its own weight and role in the availability of water [12]. The addition of organic matter in sandy soils will increase the middle-sized pores and lower the macro pores that have implications for improving the soil's ability to hold water [45]. The organic matter will improve the soil pores and will reduce the total weight of the contents of the soil [12].

The role of C-organic deposits in the improvement of soil physical properties is to create soil aggregation thus providing nest on soil conditions and can reduce soil bulk density [20]. This is supported by soil bulk density declined markedly by 19.93% on soil type entisols 6 group planting on soil type litosol, while the porosity of the soil tends to increase by 13.85% on soil type entisols 6 cluster planting, but not significant with litosol soil types. Observation of the chemical properties of the soil that covers the cation exchange capacity (CEC) and base saturation (KB), pH and nutrient content (N, P, and K), in this study indicate that the implementation of soil types entisols provide beneficial effects to the improvement of properties soil chemistry, which is characterized by an increase in soil chemical properties. Cation exchange capacity, total N, and P-provided land increased markedly on soil type entisols compared with the type of soil after planting litosol host group 2, 4 and 6 with a spacing that varies. Improved soil chemical properties is closely related to soil type entisols as a source of soil organic C.

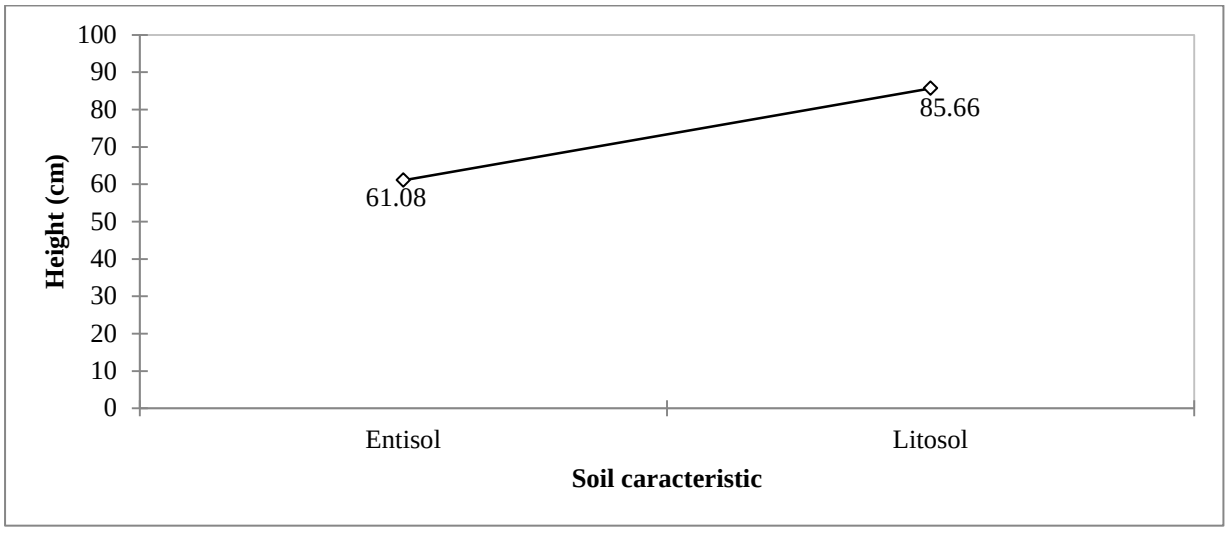

Figure 1: Effect soil type to the *Santalum album* growth with host legume and non legume

Cation exchange capacity (CEC) of the soil increased significantly by 22.35% in comparison to the type of soil entisols soil types litosol on 6 group planting. 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 so that it will increase the soil CEC [47]. Organic matter of the soil varies between 200-300 me / 100 g soil, while the CEC value of the clay only between 10 (*clays oxide*) to 100 me / 100 g soil (clay type 2: 1), so that the value CEC soil organic matter can be 2-20 times the CEC clay. The states that the organic material even if small, but great influence on the CEC, so that the higher soil organic matter the higher the soil CEC [18].

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