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Efforts to Utilise Rootlets to Increase Kaliandra (*Calliandra calothirsus*) Production

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A B S T R A C T

Leguminous plants such as calliandra have many benefits, including anti-parasitic properties. The high tannin content in calliandra can be used as an essential ingredient for medicines. This legume is classified as a type of legume that can also be used as green manure, intercropping plants, fence plants, and biofertilizers. The high production of calliandra also makes this plant useful as animal feed; root nodules formed on calliandra roots can be used as a source of N to replace the use of chemical fertilizers. This research aimed to obtain root nodules and inoculate them on plants. The experimental method was carried out by selecting calliandra root nodules and then isolating them in the laboratory to obtain isolates. Observations were made descriptively. The result showed that calliandra root nodules can induce root nodules after isolation inoculated on plants, while plants not inoculated did not form root nodules. This result will significantly help increase the production of calliandra in large quantities so that it can be utilized as animal feed, and it will also increase the production of compounds produced by calliandra plants to be utilized as medicine. Production costs can also be lowered because root nodules as plants can directly utilize a source of nitrogen found in calliandra roots.

INTRODUCTION

Calliandra can be used as an anti-parasite. Calliandra plant has a high tannin content of about 11% (Ahn et al., 1989). Tannin is an antinutritional substance in plants that is known to have anthelmintic effects. According to Shahidi and Naczk (1995), the ability of anthelmintic power derived from plants is related to the content of compounds such as tannins. Mustabi et al. (2019) showed that calliandra leaf extract had an anthelmintic efficacy on *Haemonchus contortus* nematodes.

Kaliandra is a type of legume that is often used as animal feed. Plants classified as legumes are widely used by farmers as protein source feed ingredients (Abqoriyah et al., 2015). Among the legumes that include multifunctional plants are calliandra, lamtoro, turi, desmodium, calopo, centrocema, and others.

High protein content in plants indicates that plants require high nitrogen nutrients, which can be met from the air with the help of N_2-fixing bacteria or from available nitrogen in the soil. Nutrient addition is often done by applying organic or inorganic fertilizers or liming. Ch'Ng et al. (2014) stated that organic amendments, such as biochar and compost, have been shown to improve phosphorus availability in acidic soils by altering soil chemical properties. It can increase plant P levels, particularly in low-P soils (Antoniadis et al., 2015). Adding organic matter, such as compost and manure, can also increase the efficiency of soil P use and reduce the need for P fertilizers (Erich et al., 2002).

Quickly meeting the nitrogen needs of plants can be done by chemical fertilization, such as using urea fertilizer (Afrizal et al., 2014). Urea fertilizer has a high N content for plants and plays an important role in the

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formation and growth of vegetative parts of the plant because urea fertilizer contains nitrogen, which can increase plant growth and further plant production. In every growth period, urea fertilizer is always used for optimal results. Prolonged use of chemical fertilizers will cause residues and become toxic to the soil. Biological fertilizers are an easy, safe, and cheap solution to reduce the use of chemical fertilizers such as urea (Fathin et al., 2019).

Biofertilizers that are cheap and available in large quantities can be obtained from leguminous plants, namely from their ability to form root nodules. Root nodules are abnormal tissues of plant root parts formed due to interactions between plant roots and rhizobium bacteria that support the tethering of N from the atmosphere (Suryantini, 2015). Root nodules formed from the roots of leguminous plants can be returned to the plant as an N-source fertilizer by isolating and inoculating them.

Root nodules that can be isolated are root nodules that actively bind N in the air. One of the characteristics of a split root nodule is red, but sometimes plants cannot always form root nodules. Due to the lack of supporting factors for root nodule formation, such as water and nutrients, or the low ability to compete in the soil, it needs to be inoculated to get active root nodules by helping to activate homologation-producing enzymes. Budianto and Sunarpi (2004) showed low levels of homoglutation due to the inactivity of the enzyme homoglutation synthetase, which causes inhibition of nitrogen fixation of root nodules of legume plants. Producing active root nodules either naturally or by inoculating them will help solve the problem of nutrient availability.

METHOD

The research was conducted by collecting active root nodules used as inoculants. The first treatment was collecting root nodules found on calliandra and then isolating them to authenticate isolates that can be inoculated on the next plant. Observations were made. The seeds used were taken from healthy plants. Seed selection is done by placing the seeds in a container and then adding water to the seeds to see which seeds are viable. Seeds are separated from floating seeds, damaged or wrinkled seeds, and seeds perforated by pests. Furthermore, soaking is done in cold water for 24 hours.

Sown seedlings grow well with fully developed plant organs transferred to a larger medium, a 5 kg polybag. After six weeks, the plants were harvested to see their ability to form root nodules.

Maintenance during planting is done by watering in the morning and evening using a hand sprayer. Watering is under the capacity of the field to keep the media from flooding in the germination tub, aiming to keep the plants from rotting. Next, root nodule harvesting is carried out, and the following process is carried out in the laboratory.

RESULTS AND DISCUSSION

Many benefits are found in calliandra plants. Apart from being a root medicine, this plant also can form root nodules. Some legumes cannot form root nodules. It is because there are conditions that can inhibit the formation of root nodules due to the failure of bacterial infection to the roots for root nodule formation (Suryantini, 2015). The results of the evaluation of root nodule development of calliandra and several other leguminous species can be seen in Table 1.

Table 1. Root nodule development in some leguminous crops

No	Observation	*Lamtoro*	Callindra	*Turi*
1	Colour	-	White	White
2	form	-	Irreguler	Round
3	Location	-	Root secunder	Root secunder

Table 1 shows that the color of the root nodules is white. The shape of root nodules is round and irregular (Figure 1), with root nodules located on root branches. The color obtained characterizes that rhizobium bacteria already exist and live in the root nodule but are not yet active in binding N_2. The effectiveness of a root nodule is influenced by the bacteria itself and environmental factors. According to Trustinah (1993), the formation of root nodules can be influenced by several factors, which are generally abiotic factors such as soil pH, rhizobium type, temperature, and soil conditions. Rhizobium generally grows optimally at a temperature of 25-30°C. Drought conditions can reduce the survival rate of rhizobium rapidly.

Figure 1: The Irregular Shape of Root Nodules

Low homoglutation synthetase enzymes can also cause the lack of effectiveness of root nodules. According to Budianto and Sunarpi (2004), low levels of homoglutation, due to the inactivity of the homoglutation synthetase enzyme, cause inhibition of nitrogen fixation in the root nodules of legume plants in water deficit conditions.

Plants unable to form root nodules can do so through inoculation as a biofertilizer. According to Okur (2018), biofertilizers, which are living microorganisms, play a crucial role in enhancing nutrient availability in the soil for plant growth. One source of inoculants that can be used is root nodules. Root nodules are formed in leguminous plants' roots due to rhizobium symbiosis.

According to Augusta et al. (2019), this inoculation aims to create root symbiosis between plant roots and bacteria to form root nodules. Inoculation of rhizobium in soybeans is done to assist plants in nitrogen fixation so that it is expected to meet the N needs of plants and soil. According to Kaschuk et al. (2009), rhizobium increases plant photosynthesis by acquiring nitrogen and phosphorus. This increase is due to the efficiency of plant nutrient use increased through adaptation mechanisms. Rhizobium inoculation had a significant effect on plant height. Rhizobium inoculation increased plant height compared to no inoculant.

Research results on calliandra plants have not yet formed any root nodules in the soil naturally, and after inoculation, root nodules can be formed in varying sizes and white (Table 2).

Table 2. Root nodule formation naturally and by inoculation in Calliandra plants

Observation	No Inoculation	Inoculation
Root nodule	-	Nodul
form	-	Varied
Colour	-	White

According to Denton et al. (2002), inoculant rhizobia typically needs to compete with naturalized soil populations of rhizobia to form legume nodules on clover in alkaline; therefore, a competitive inoculant is needed, isolated from root nodules with rhizobium that can compete in nature. The ability of legumes to form root nodules varies. Some legumes cannot form root nodules. The cause of the nodules is not formed because, in these conditions, there are inhibitors in the formation of root nodules, namely due to the failure of bacterial infection to the roots to induce root nodule formation (Suryantini, 2015).

CONCLUSIONS

After isolation, root nodules found in calliandra roots then inoculated in plants showed that the roots can induce root nodules again, while plants not inoculated did not form root nodules. This result will significantly help increase the production of calliandra in large quantities so that it can be utilized as animal feed, and it will also increase the production of compounds to be utilized as medicine.

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