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Encapsulation of Moluccan albizia's (*Paraserianthes falcataria*) seeds to support tree plantation program in urban areas

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Abstract. *Sukiman H, Lekatompessy S, Widowati T, Nurjanah L, Nuriyanah. 2015. Encapsulation of Molluccan* albizia*'s (*Paraserianthes falcataria*) seeds to support tree plantation program in urban areas. Nusantara Bioscience 7: 128-132.* Green open space in urban areas and their outskirt is an essential requirement for healthy and clean cities. The success of tree plantation program requires the availability of high-quality seeds. Several relevant researches have produced technologies which can support tree plantation programs, among others, are seed encapsulation methods and the use of microbes for biological fertilizers. Encapsulation of seeds is aimed at protecting the seeds from extreme conditions that may occur during germination and, at the same time, providing microbes for the seedling growth. Results showed that nitrogen-fixing bacteria could be included in various materials of carriers for Moluccan albizia's (*Paraserianthes falcataria*) seeds. The microbes which grow in agar media as a carrier become the best encapsulation method compare to microbes grow in other carriers.

Keywords: encapsulation, microbes, biological fertilizers

INTRODUCTION

The establishment of green open spaces in urban areas and their outskirts is essential to human life. Human activities in the cities are getting more intensive due to urbanization and increased economic needs, as well as profession transition trend from farmers to entrepreneurs. Green open spaces are, therefore, important to help reduce pollution, to supply oxygen, and to provide recreation area for people. The Indonesian Act No.26, 2007 regarding Land Use Plan stipulates that every province, district, and city in Indonesia must designate 30% of its land as green open spaces. The green open spaces include urban forest, arboretum, open spaces along the roads, and agriculture land on the outskirt of the city. However, in reality, green open spaces in several cities, such as Jakarta, only occupied approximately 10% of the whole area.

The selection of plants for a city park should be adjusted with the condition in the surrounding area. Fast-growing species which have dense crown are more preferable because they have various benefits for urban people such as to provide shades. Another criterion is their ability to withstand drought and air pollution, so they survive during wet and dry season. High-quality seedlings must be used. Thus, according to Kosmiatin (2012), healthy superior and high-quality seedlings are needed. These seeds can be produced through an applicable technique called seeds encapsulation method.

Soil is a large source of microbe diversity. Many species of microbes live in the soil, each having specific ability, one of which is fixing free nitrogen from the air. Soil microbes which can help plants pick up phosphate and other nutrients including water from the soil are mycorrhizae. Application of both microbes can improve plant growth; therefore both microbes can be combined in biological fertilizer packages.

The utilization and application of beneficial microbes for plants can be done in several ways, one of which is seed encapsulation (Redenbaugh and Ruzin 1988). Seeds are packed and wrapped in a carrier which has been given the microbes. When the seeds germinate, there is a possibility that the microbes will infect the roots and build mutualistic symbiosis with the plants (Burhanuddin 2012). Seed encapsulation is very useful if the seedlings were moved from nurseries to the fields because they will survive acclimatization period which may have extreme conditions. The symbiont microbes will help the seedlings search for nutrients and water, and help to survive until its roots are well developed and able to search for nutrients.

The objective of this study is to analyze seed encapsulation technique by involving particular microbes to support seedling growth, as well as to improve the quality and survival ability of seedlings in the field through seeds encapsulation techniques.

MATERIALS AND METHODS

Microorganisms

The microbes were used as parts of encapsulation materials of Molluccan albizia's (*Paraserianthes falcataria* (L)) seeds, where nitrogen-fixing bacterium BTCC-BF1.3 isolated from root nodules and vascular arbuscular mycorrhiza, produced by Indonesian Institute of Science

(LIPI) named BIOVAM LIPI. Compost was added in encapsulation material as source of organic matter for both the seedlings and the microbes. Regeneration of BTCC-BF1.3 was done by growing it in Yeast Extract Mannitol Agar (YEMA) media (Somasegaran and Hoben1985). Production of bacterial cellular mass was done by growing the bacterium in Yeast Extract Mannitol Broth (YMB) media, incubated by shaking in a shaker for 2-3 days. This suspension of bacterium was then used as a mixture for encapsulation materials.

Encapsulation materials

The material for encapsulation was YEMA media, which functioned as media for bacterial growth and glue for seeds, to support the material stuck to the surface of the seeds. One hundred milliliters of YEMA was mixed with 10 ml of microbes' inoculum. Then, the paste of mixed materials was mixed with solid compost and BIOVAM LIPI as phosphate fixers. After having been mixed thoroughly, the paste can be used as material for encapsulation of Moluccan albizia's seeds. Other carrier materials tested in this study were compost and soil containing mycorrhizae.

The Moluccan albizia's seed and encapsulation technique

The Moluccan albizia's seeds were collected from three locations in West Java, namely Bogor, Garut and Tasikmalaya. In order to get high-quality seeds, germination test was conducted with the following procedures: The seeds were soaked in hot water for several minutes. They were put in Petri dishes lined with filter paper afterward, wetted with sterile water. Then, the Petri dishes were incubated in the dark at ambient temperature for 3-4 days until the seeds germinated. The percentage of germination was determined by counting the number of germinating seeds per 100 seeds spread.

The encapsulated albizia's seeds were air-dried and then spread on plastic trays containing sterile sand media. Then, the trays were put in a glass house for recording the data of germination rate, growth rate (%/etmal) after 21 days, and seedling vigor. Growth rate is the percentage of normal seedlings per unit of time or etmal (Sadjad 1994), meanwhile, seedling vigor includes the general condition of leaves, uprightness of seedlings, color of leaves and general conditions of the seedlings. Progeny of seeds (adaptation power of seeds) and the origins of seeds were also recorded.

RESULTS AND DISCUSSION

Nitrogen-fixing and phosphate-dissolving bacteria

Nitrogen-fixing bacteria have long been studied intensively. These microbes can be isolated from soil and plants, particularly root, xylem and phloem tissues. These

Figure 1. The stages of encapsulation of to get high-quality seeds or Moluccan albizia's (*Paraserianthes falcataria* (L). Nielsen seeds

bacteria can live in mutualistic symbiosis or an association with plants in rhizosphere. In the mutualistic symbiosis between plants and the bacteria, the plants get macro and micro essential elements including water, while the microbes get energy. In addition, the microbes produce active compounds acting as protector for plants against various diseases.

The most known nitrogen-fixing bacteria are those from the family Rhizobiaceae. These bacteria are capable of producing nitrogenase required for fixing free nitrogen from the air and convert it into forms available to plants (Dwidjoseputro 2015). Many of these bacteria have been selected especially in relation to their superiority in fixing free nitrogen from the air. In addition to the bacteria, mycorrhizae have been known for their ability to dissolve phosphate. These fungi infected plant roots by inserting their hyphae into root tissues and break down the phosphate compounds that are unavailable to the plants. In addition, they also produced active compounds to plants, such as plant growth hormones and antimicrobial hormones. These phosphate-dissolving bacteria can be used as biological fertilizer because of their ability to dissolve phosphate bound to other elements (Fe, Al, Ca, and Mg), so the phosphate becomes available to plants (Wulandari 2001; Suliasih and Rachmat 2007). In addition, the phosphate-dissolving bacteria also secrete organic acid which can reduce soil pH and break down active compounds, increased phosphate availability to plants. Pamuna et al. (2013) state that application of mycorrhizae increases dry weight of plants. Mycorrhizae can be isolated from the soil for their specific superiority. These selected mycorrhizae are then developed into biological fertilizers and mixed with seed carriers used as materials for seed wrappers (Marista et al. 2013).

Encapsulation of Moluccan albizia's seeds

Seed encapsulation is seed packaging using carrier materials mixed with microbes as biological fertilizers to improve seedling growth. This seed encapsulations technique was developed by Redenbaugh and Ruzin (1988) which lead to somatic embryo wrapping with natrium alginate enriched with microorganisms, such as Rhizobium and mycorrhizae. There are several embryo and seed wrappers such as hydrogel natrium alginate and polyethylene oxide (Warnita and Suliansyah 2008). Meanwhile, materials of seed carrier commonly used are soil, rice powder, and cassava powder. The seeds wrapped with biological fertilizers are known as artificial seeds (Redenbaugh and Ruzin 1988). The materials for seed carriers are usually used as habitat to support the life of the microbes. Nitrogen-fixing and phosphate-dissolving microbes are mixed with the carrier materials and then the seeds wrapped with the materials. Encapsulation of seeds is commonly done because fertilization in the fields cannot always be carried out continuously due to technical constraints.

Table 1 shows that albizia's seeds from Tasikmalaya were better than those from Garut and Bogor, because the seeds quality and the storage of were good. The results showed that the natural seeds (the seeds which were not encapsulated) had higher germination rate and seedling growth than the encapsulated seeds with media containing microbes, compost, and soil as carrier for mycorrhizae.

Figure 2 shows that the germination rate of albizia's natural seeds was 64% and the seedling growth rate was 14.323% etmal, whereas the germination rate of encapsulated seeds using microbe growth media and compost (treatment I) had better germination rate and seedling growth than those encapsulated seeds of treatments II (microbe growth media containing compost and microbes), and treatment III (microbes growth media, compost and soil containing mycorrhizae and bacteria). Microbe growth media containing gel was the best encapsulation materials, because the growth media YEMA supports microbe growth and serves as glue to the surface of the seeds (Redenbaugh and Ruzin 1988). Compost is also source of organic matter needed by plants and microbes. The data showed that the best growth results were found in seeds from Bogor which encapsulated in treatment II without soil that contained mycorrhizae.

Figure 3 shows the growth rate of albizia seedlings germinated from natural seeds was4.891%, which is higher than those from encapsulated seeds, because the addition of soil increased the density and hardness of the encapsulation material. This caused the seedlings failed to pierce through the skin of the seeds when the seeds germinated. The seedlings were unable to pierce through the wall when the materials of encapsulation dried. It is important that the kind of encapsulation materials should match the ability of seedlings to be able to pierce through the materials when the seeds germinate. In addition, optimizing of encapsulation materials and the content of fertilizers can determine the quality of the encapsulated seeds. Figure 3 shows that although seedlings had better growth rate, the unsuitable encapsulation materials could impede the growth of the seedlings.

Vigor is the ability of seedlings to grow normally in sub-optimal condition. According to Pramono (2010), the effect of early seedling vigor is important. Seedling viability and vigor are indicating rapid and normal growth of seedlings (Syamsuddin et al. 2011). The results vigor observation showed that seedlings germinated from encapsulated seeds still grew normally as indicated by good condition of green upright leaves. In general, viability and vigor of seedlings decrease with the increase of temperature. The thickness of encapsulation materials causes the lesser amount of oxygen which results in the decrease of germination rate and growth rate of seedlings (Sadjad 1972).

The selection of materials of carrier is important because the materials of encapsulation are source of carbon for microbes as well as glue on the surface of seeds that may cause contamination of other microbes. The ingredients of encapsulation materials in relation to their texture must be selected carefully in order to give good aeration for the seeds. Germination rate and growth rate of seedlings are the main parameters determining the ability of seedlings to grow optimally. To avoid contamination of other microbes, a preliminary study needs to be conducted using semi-sterile media. The media has to be sterilized

Table 1.Theeffect of encapsulation of Moluccan albizia's seeds on the germination rate, growth rate and vigor of seedlings

Treatment	GR (%)	GtR (%/etmal)	Vigor		
			Leaf condition	Uprightness	Leaf color
I Bogor	13	2.318	Good	Upright	Green
I Garut	37	4.891	Good	Upright	Green
I Tasikmalaya	36	4.480	Good	Upright	Green
II Bogor	4	0.401	Good	Upright	Green
II Garut	4	0.485	Good	Upright	Green
II Tasikmalaya	19	2.366	Good	Upright	Green
III Bogor	5	0.453	Good	Upright	Green
III Garut	13	1.362	Good	Upright	Green
III Tasikmalaya	14	1.578	Good	Upright	Green
Control Bogor	36	6.812	Good	Upright	Green
Control Garut	64	14.323	Good	Upright	Green
Control Tasikmalaya	49	9.686	Good	Upright	Green

Note:GR: germination rate, GtR : Growth rate, Control: without treatment, Treatment I:YEMA 100 mL + compost 100 gr, Treatment II:YEMA 100 mL + compost 100 gr + Microbes 10 mL, Treatment III:YEMA 100 ml + compost50 g + Mycorrhizae 50 g + Microbes 10 mL

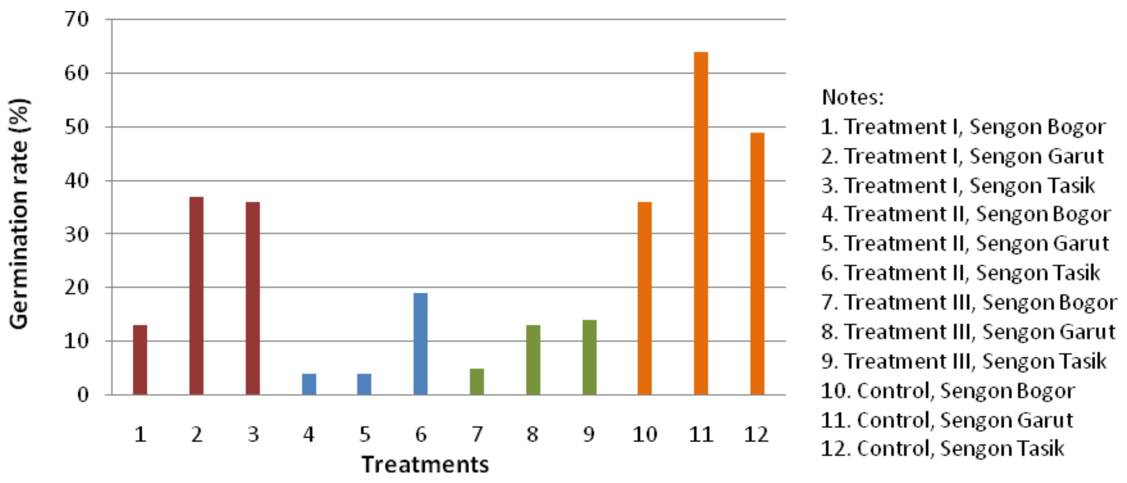

Figure 2. Germination rate of encapsulated Moluccan albizia's seeds

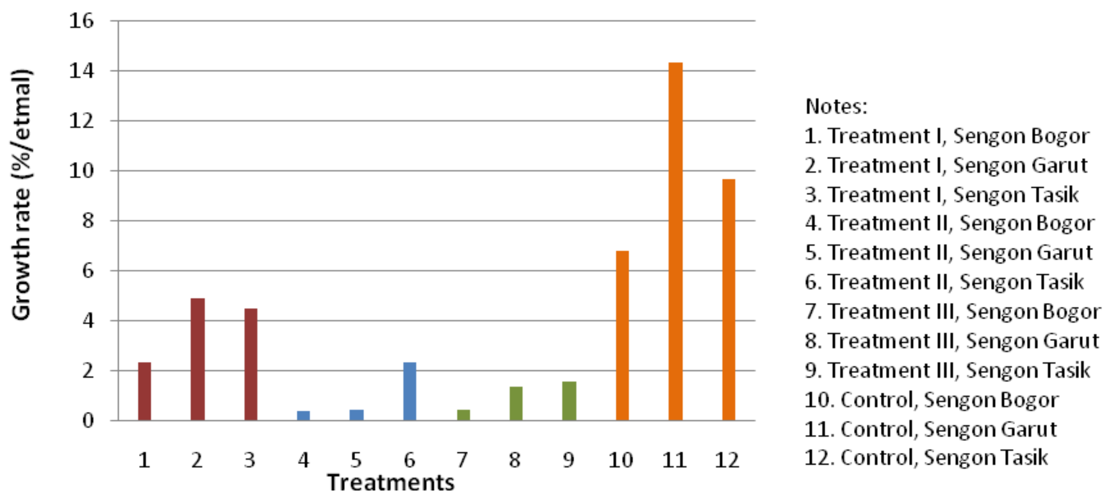

Figure 3.The growth rate of seedlings germinated from encapsulated Moluccan albizia's seeds

using simple methods to improve the success of encapsulation techniques. The microbes used for seed encapsulation must be compatible with the seeds. This way, the encapsulation techniques can help to facilitate the spread of seeds in the field by maintaining the normal germination rate of seeds and growth rate as well as the optimal vigor of seedlings.

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