EMBIO™ actinoPLUS FOR BIOLOGICAL CONTROL OF *Ganoderma* DISEASE

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652

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MPOB has introduced the Integrated *Ganoderma* Management (IGM) which incorporates biological control by using microorganism antagonists against basal stem rot (BSR) or *Ganoderma* disease (Idris, 2011). Studies by several researchers have shown that many species of beneficial microorganisms including actinomycetes, bacteria and fungi have the ability to effectively suppress plant diseases. Actinomycetes are a group of microorganisms which produce secondary metabolites with biological activities such as antibiotic, anti-fungal, anti-viral, plant growth factors, enzymes and enzymes inhibitor (Berdy, 2005). The filamentous gram positive bacteria are inhabiting the soil (Kim *et al.*, 1998) and rhizosphere (Sardi *et al.*, 1992). They are widely distributed in the natural ecosystem (Srivinasan *et al.*, 1991). As they represent a large part of the rhizosphere microbial flora (Sardi *et al.*, 1992), it has been shown that they could influence plant growth and protect plant roots against invasion of root pathogenic fungi (Crawford *et al.*, 1993; Cao *et al.*, 2004). The usage of actinomycetes as potential biological control agents of soil-borne root diseases is of interest. The potential of actinomycetes as a root coloniser and fungal antagonist to plant pathogen was reported by Kunoh *et al.* (2000). *Streptomyces* GanoSA1 was developed into organic powder for controlling BSR disease in oil palm (Shariffah-Muzaimah *et al.*, 2012). The *Streptomyces* GanoSA1 was isolated from the rhizosphere of oil palm plantations. *Streptomyces* GanoSA1 is a non-pathogenic actinomycete with a strong inhibition ability against *G. boninense*, both *in vitro* and *in vivo* (Shariffah-Muzaimah *et al.*, 2012).

THE TECHNOLOGY - EMBIO™ actinoPLUS

The *Streptomyces* GanoSA1 was developed onto organic dry formulation powder which consisting of vermiculite and biochar, namely as EMBIO™ actinoPLUS (*Figure 1*). The process of mass production of *Streptomyces* GanoSA1 inoculum was established and patented.

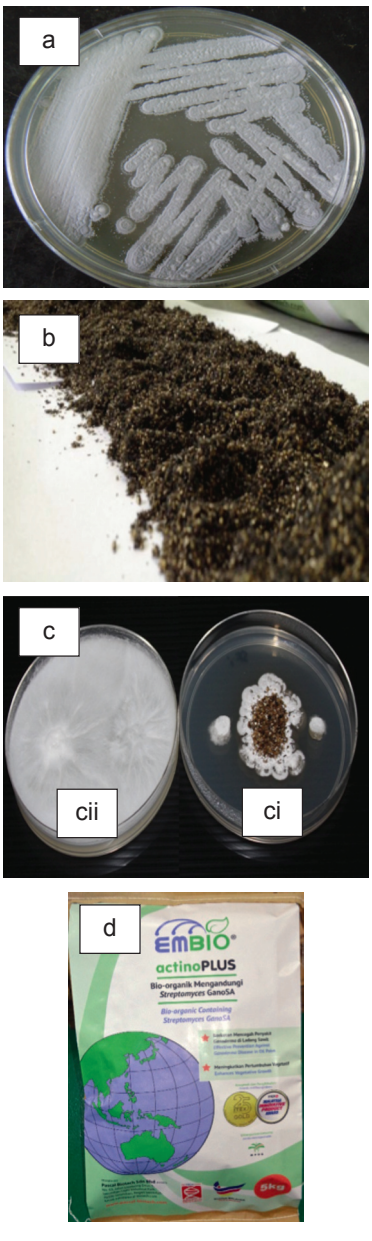

Figure 1. EMBIO™ actinoPLUS. (a) Pure culture of Streptomyces *GanoSA1, b) organic powder containing vermiculite, biochar and* Streptomyces *GanoSA1, (c) activity of EMBIO™ actinoPLUS powder against* Ganoderma boninense *(ci)* in vitro *compared to control plate (cii) at seven days after incubation and (d) EMBIO™ actinoPLUS packaging.*

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QUALITY OF EMBIO™ actinoPLUS

The colony forming unit per gram (CFU g^{-1}) of *Streptomyces* GanoSA1 at room temperature (27 ± 2ºC) was determined for 12 months. The initial quantity of *Streptomyces* GanoSA1 in organic powder formulation was 10^8 CFU g^{-1}, remained at 10^8 CFU g^{-1} after one month, then reduced to 10^6 CFU g^{-1} after six months and finally to 10^4 CFU g^{-1} after 12 months of storage.

BENEFITS OF EMBIO™ actinoPLUS

- Effective in controlling *Ganoderma* disease.
- Environmental-friendly product.
- Cheaper compared to chemical fungicide.
- Easy to apply in the nursery and field.

EFFECTS OF EMBIO™ actinoPLUS ON VEGETATIVE GROWTH OF OIL PALM SEEDLINGS

The effects of EMBIO™ actinoPLUS on vegetative growth of oil palm seedlings was carried out in the nursery for nine months. Two treatments were evaluated with 30 seedlings per treatment. The treatments were: T1-untreated seedlings (control) and seedlings treated with actinoPLUS applied at monthly intervals (nine applications, 50 g/seedling/application). At nine months after treatment, the plant height of seedlings treated with actinoPLUS (147.3 cm) was significantly ($p<0.05$) higher compared to untreated seedlings (132.8 cm). The seedlings treated with actinoPLUS showed a significantly ($p<0.05$) higher frond production (14.9 fronds) compared with the untreated seedlings (12.6 fronds). The relative leaf chlorophyll (Chl) content was lower in the untreated seedlings (50.2 Chl SPAD) compared to the seedlings treated with actinoPLUS (57.2 Chl SPAD).

EFFECTS OF EMBIO™ actinoPLUS IN CONTROLLING *Ganoderma* DISEASE IN OIL PALM SEEDLINGS

The formulation of EMBIO™ actinoPLUS was examined for its efficacy as a biological control agent *in vitro* and in subsequent disease control in oil palm seedlings against *Ganoderma boninense* in the nursery. Two treatments were evaluated (*Table 1*) with 30 seedlings per treatment. For treated seedlings, actinoPLUS was applied four times (at 3, 4, 7 and 10 months old, 50 g/seedling/application). Seedling was inoculated with *G. boninense* using rubber wood block sitting technique (Idris *et al.*, 2006). The effectiveness of EMBIO™ actinoPLUS in controlling BSR was evaluated based on quantitative assessment measured as disease incidence (DI), dead seedlings (DS) and disease reduction (DR). At eight months after treatment, the DI of seedlings treated with actinoPLUS (50.0%) was significantly ($p<0.05$) different compared to that of untreated seedlings (93.3%). Seedlings treated with actinoPLUS recorded significantly ($p<0.05$) lower of dead (43.3%) as compared to untreated seedlings (73.3%). BSR disease incidence was reduced 65.2% in seedlings treated with actinoPLUS (*Table 1*).

TABLE 1. EFFECTS OF EMBIO™ actinoPLUS ON BASAL STEM ROT (BSR) DISEASE DEVELOPMENT IN OIL PALM SEEDLINGS AT EIGHT MONTHS AFTER TREATMENT

Treatment	Disease incidence (%)*	Dead seedlings (%)*	Disease reduction (%)
Untreated seedlings and inoculated with *G. boninense* (control, T1)	93.3a	73.3a	
			65.2
Seedlings treated with actinoPLUS and inoculated with *G. boninense* (T2)	50.0b	43.3b	

Note: *Columns with the same letter indicates no significant difference at $p<0.05$ using Least Significant Difference (LSD).

EFFECTS OF EMBIO™ actinoPLUS IN CONTROLLING *Ganoderma* DISEASE IN FIELD PLANTED OIL PALM

Field testing of the EMBIO™ actinoPLUS to control *Ganoderma* disease was investigated through seedling baiting technique at two sites in Teluk Intan, Perak. Two treatments were evaluated: T1-untreated seedlings (control); and seedlings treated with actinoPLUS (T2). Thirty seedlings were used per treatment. For treated seedlings, actinoPLUS was applied four times (in nursery at 4, 7 and 10 months old, at 50 g/seedling/application and in planting hole, at 250 g/hole). Twelve-month old seedlings were planted 35 cm away from *Ganoderma* infected palm (*Figure 2*). Disease assessments were carried out at three-monthly intervals. After 30 months, no symptoms of BSR disease and dead palms were observed on seedlings treated with actinoPLUS (*Figure 2*). About 23.3% (14 out of 60 palms) of the untreated seedlings were dead due to *Ganoderma* infection. Palm dead was confirmed due to *Ganoderma* using the *Ganoderma* selective

medium (GSM) as described by Ariffin and Idris (1992).

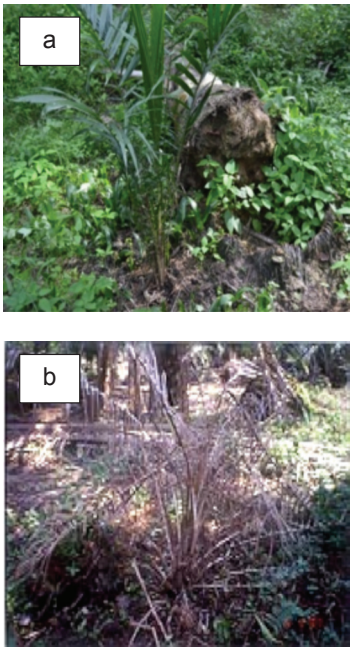

Figure 2. Field evaluation of EMBIO™ actinoPLUS through seedling baiting technique, 30 months after planting. (a) Seedling treated with actinoPLUS with no Ganoderma *infection, and (b) untreated seedling dead due to* Ganoderma *infection.*

CONCLUSION

The use of EMBIO™ actinoPLUS can contribute positively towards controlling the *Ganoderma* disease, therefore reducing potential yield losses due to *Ganoderma* infection in oil palm plantations. The product is non-pathogenic to non-target organisms and environmental-friendly.

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