EcoB8: MICROBIAL CONSORTIA BASED BIO-FERTILISERS

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The term bio-fertiliser or 'microbial inoculants' is defined as a preparation containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilising or cellulolytic microorganisms used for application on soil or composting areas with the objective of increasing the number of such microorganisms and accelerate certain microbial process to augment the extent of the availability of nutrients in a form which can be assimilated by plant (NIIR Board, 2004). Unlike chemical fertilisers, bio-fertilisers prevent pollution and environmental-friendly. Living microorganisms used in the preparation of bio-fertilisers promote the adequate supply of nutrients to the host plants and ensure their proper development of growth and regulation in their physiology (Mirsha *et al.*, 2013).

Minerals, organic components and microorganisms are three major solid components of the soil, which affect the physical, chemical and biological properties and processes of terrestrial systems. Organisms that are commonly used as bio-fertilisers component are nitrogen fixers (N-fixers), potassium solubilisers (K-solubilisers) and phosphorus solubilisers (P-solubilisers), or with the combination of molds or fungi. Many bacteria and fungi are able to improve plant growth by solubilising inorganic and organic phosphates in the soil (Rodriguez and Fraga, 1999; Whitelaw, 1999). Fungi have been reported to possess greater ability to solubilise Rock Phosphate than bacteria (Nahas, 1996). Bio-fertilisers being essential components of organic farming play vital role in maintaining long-term soil fertility and sustainability, reduce the problems of land degradation, increasing soil fertility and overcome rapidly declining production levels (Khosro and Yousef, 2012; Mirsha *et al.*, 2013).

OBJECTIVES

- To increase oil palm nutrients uptake.
- To increase palm growth.
- To reduce *Ganoderma* infection.
- To reduce use of chemical fertilisers.
- To prevent soil degradation.
- To reduce pollution and create ecologically-friendly oil palm.

METHODOLOGIES

EcoB8

EcoB8 are eco-friendly bio-fertilisers containing compatible NPK prokaryotes and selected rotting fungi screened to be excellent lignocelluloses degraders as well as *Ganoderma* inhibitors. Eight EcoB8 were tested, each has different microbial consortia.

Application of EcoB8

The delivery of EcoB8 to oil palms is by applying into soil at the rate of 1 kg per palm for one to three years old oil palm and 3 kg per palm for four to six years old oil palm and 4 kg per palm for oil palm above six years. Three rounds of EcoB8 applications are needed per year.

Field Performance of EcoB8

A total of 296 eight months old oil palm seedlings fertilised using eight microbial consortia with four low levels of standard fertilisers, 0% (T1), 20% (T4), 30% (T5) and 40% (T6) and four controls namely, standard fertiliser (SF1), (SF2), blank and mycorrhizal product (MP) were transferred from the nursery to the field with old palms badly infected with *Ganoderma boninense*. For each treatment, eight palms were planted around old palms with lower trunk colonised by many *Ganoderma* fruiting bodies. Fertilisation with the EcoB8 and controls were undertaken quarterly, until the palms became three years old. At the age of 21 to 36 months, palm height, meristem diameter, number of fronds, classes of *Ganoderma* infection 1 to 4 were recorded quarterly. Leaflets from frond number 9 and soil sample around each oil palm were taken for nutrients and microbial analysis, respectively.

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RESULTS AND DISCUSSION

Two out of eight EcoB8, namely the EcoB8.1(T4) and EcoB8.2(T5) were selected and recommended for good foliar nutrients uptake, *Ganoderma* inhibition and consistent vegetative growth. EcoB8 resulted in more diversified underground microbial population as compared to chemical fertiliser (*Figure 1*). EcoB8 promoted the growth of various species α, β, and γ-Proteobacteria. While, with the use 100% chemical fertiliser, the phylum Firmicutes dominated and α, β, and γ-Proteobacteria either disappeared or reduced (*Figure 1*).

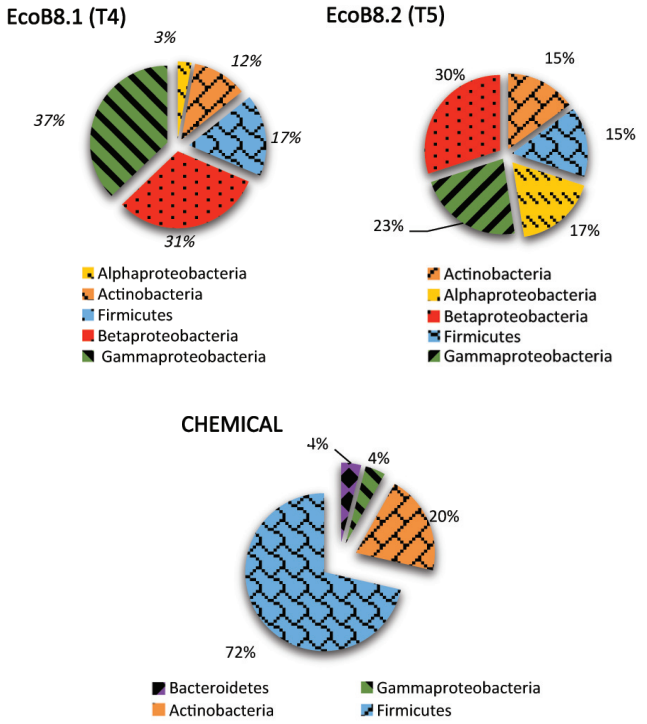

Figure 1. Soil bacterial taxanomic composition for oil palm fertilised using different EcoB8 biofertilisers. [EcoB8.1 (T4)] Microbial consortia 6 with 20% of chemicals fertiliser, [EcoB8.2 (T5)] = Microbial consortia 8 with 30% of chemical fertiliser.

Field performances of EcoB8 bio-fertilisers on oil palm at Ladang Sungei Gerchang, Johor indicated EcoB8 (*Figure 2*) gave better vegetative growth of oil palm than 100% chemical or SF1 (*Figure 3*) and blank or premium compost (*Figure 4*).

Palms aged three years fertilised with EcoB8 indicated significantly high meristem diameter and height at p=0.05, as compared to chemical (*Table 1*). Statistical analysis of vegetative measurement and nutrients uptake showed that EcoB8.1(T4) and EcoB8.2(T5), were significantly better compared to chemical at p=0.05, and showed no *Ganoderma* infection (*Table 2*) and gave consistent growth (*Table 1*).

Figure 2. Oil palm fertilised with EcoB8.2 (T5).

Figure 3. Oil palm fertilised with chemical.

Figure 4. Oil palm fertilised with Premium compost.

Field application of EcoB8 increased the soil pH, foliar macro nutrients such as N, P, K, Mg, Bo, and foliar K , Bo and Mg were significantly higher at P=0.05 as compared to 100% chemical. For palm aged three years, foliar N was 2.85% for EcoB8.1 (T4) and EcoB8.2 (T5) significantly higher as compared to 2.58% for 100% chemical fertiliser (*Figure 5*). Foliar potassium was significantly higher at p=0.05 for majority of the EcoB8 which ranged from 4600 - 6200 mg litre^{-1} as compared to chemical, 3600 mg litre^{-1} (*Figure 5*). As for foliar Bo ranged from 26 - 29 mg litre^{-1} with EcoB8 as compared to chemical, 5.8 mg litre^{-1} (*Figure 5*). While C and foliar micro nutrients Mn, Ca, Fe, Mo, Zn and Cu for oil palm aged three years were comparable to 100% chemical fertiliser.

EcoB8 significantly reduced foliar heavy metals Ni, Cr, Cd and Pb at p=0.05 (*Figure 6*) and reduced *Ganoderma* infection from 25 % for 100% chemical fertiliser and 12.5% in blank to 0% for EcoB8 (*Table 2*).

ECONOMIC ANALYSIS

EcoB8 with 20% to 30% chemical fertiliser perform better than 100% chemical fertiliser. With EcoB8, the plantation can reduce 70% to 80% of the current cost of chemical fertilisers.

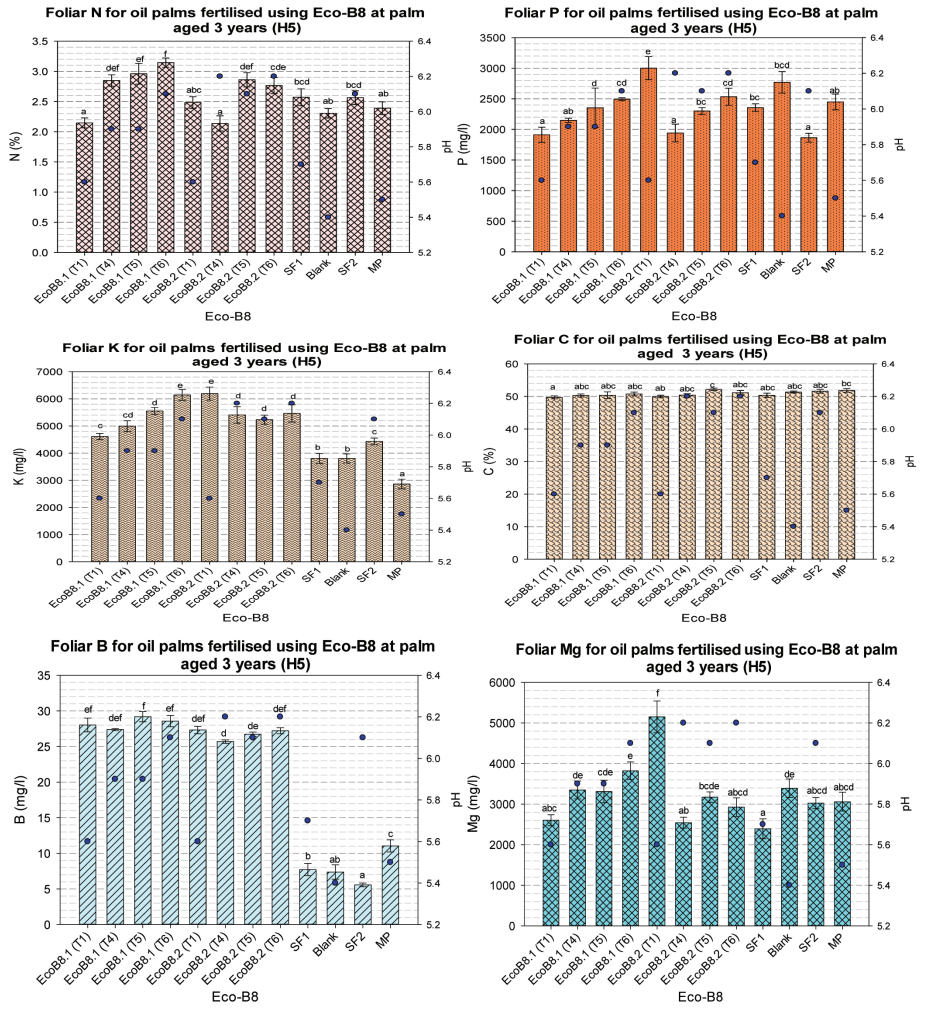

Figure 5. Foliar major nutrients for oil palm aged three years fertilised using EcoB8. Microbial concortia, EcoB8.1 and EcoB8.2 and (T1), (T4), (T5) and (T6) with 0%, 20%, 30% and 40% chemical standard fertiliser (SF1), respectively.

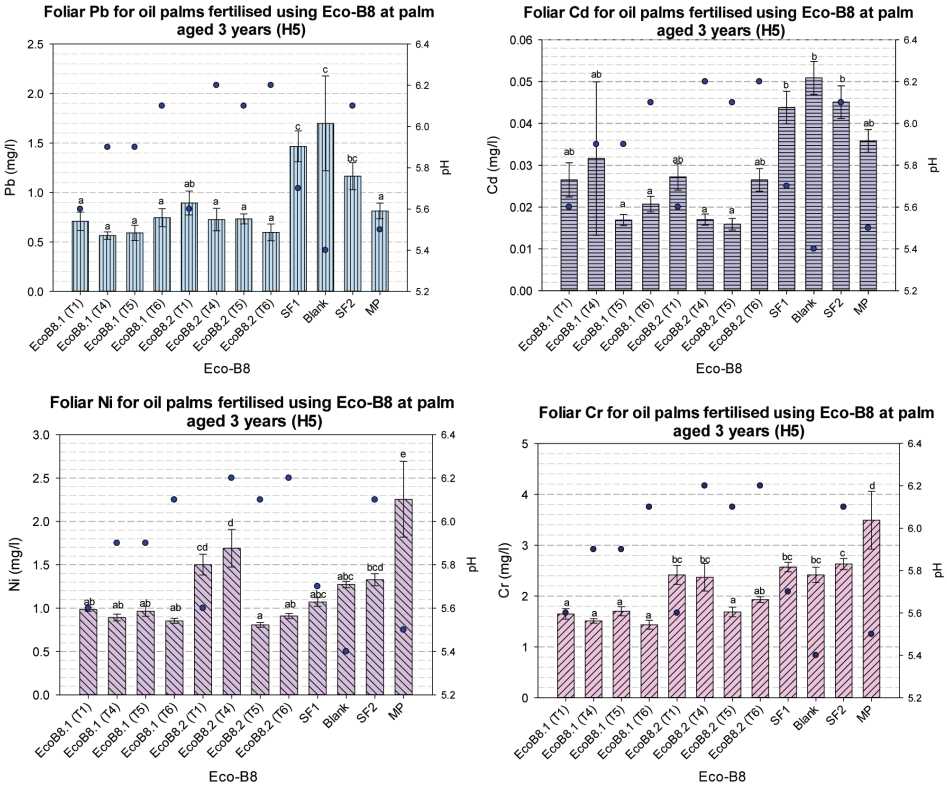

Figure 6. Foliar heavy metals for three years oil palm fertilised using EcoB8. Microbial concortia, EcoB8.1 and EcoB8.2 and (T1), (T4), (T5) and (T6) with 0%, 20%, 30% and 40% chemical standard fertiliser (SF1), respectively.

TABLE 1. VEGETATIVE MEASUREMENTS OF OIL PALM FERTILISED USING EcoB8 UP TO THREE YEARS

Treatments	Height (cm)	Meristem diameter (cm)	Number of fronds
EcoB8.1(T1)	326.25±18.31(de)	39.01±0.93 (c)	21.12±0.74 (bc)
EcoB8.1(T4)	375.00±12.67(f)	40.16±0.52 (c)	23.87±0.83 (c)
EcoB8.1(T5)	307.50±16.77(cd)	36.50±1.52 (c)	23.50±1.50 (c)
EcoB8.1(T6)	288.75±23.33(b)	29.97±2.34 (b)	22.30±0.94 (bc)
EcoB8.2(T1)	363.75±15.46(de)	29.49±1.49 (b)	20.87±1.13 (bc)
EcoB8.2(T4)	311.25±17.87(cd)	29.89±0.93 (b)	21.62±1.88 (bc)
EcoB8.2(T5)	356.25±29.15(de)	25.87±3.15 (ab)	21.12±0.76 (b)
EcoB8.2(T6)	352.50±25.82(de)	31.05±3.47 (b)	20.62±0.50 (b)
SF1	292.50±24.54(bc)	22.49±2.96 (a)	18.25±2.03 (ab)
Blank	240.00±11.33(a)	27.22±1.69 (ab)	21.00±1.62 (bc)
SF2	372.85±17.14(ef)	28.07±0.90 (ab)	17.28±1.10 (a)
MP	273.75±11.94(b)	26.75±1.90 (ab)	18.85±1.50 (ab)

Note: EcoB8.1 and EcoB8.2 are formulations with microbial consortium number 6 and consortium number 8, (T1), (T4), (T5) and (T6) with 0%, 20%, 30% and 40% standard fertiliser (SF1) added to the formulation, respectively. Values in the same column with the same letters are not significantly different at p= 0.05.

TABLE 2. *Ganoderma* INFECTION OF OIL PALM FERTILISED USING EcoB8

Treatments	*Ganoderma* infection (%)
EcoB8.1 (T1)	0
EcoB8.1 (T4)	0
EcoB8.1 (T5)	0
EcoB8.1 (T6)	12.5
EcoB8.2 (T1)	0
EcoB8.2 (T4)	0
EcoB8.2 (T5)	0
EcoB8.2 (T6)	0
SF1	25.0
Blank	12.5
SF2	0
MP	0

Note: EcoB8.1 and EcoB8.2 are formulations with microbial consortium number 6 and consortium number 8, (T1), (T4), (T5) and (T6) with 0%, 20%, 30% and 40% standard fertilisers (SF1) added to the formulation, respectively. Controls are (SF1), (SF2), blank and mycorrhizal product (MP).

BENEFITS

- Increase nutrients uptake.
- Cost effective.
- Sustain soil fertility.
- Prevent soil degradation.
- Reduce *Ganoderma* infection.
- Protect the environment and eco-friendly.

CONCLUSION

The application of EcoB8 containing microbial consortia is mandatory to restore and maintain the effective microbial populations within the soil, for solubilisation and mobilisation of palm nutrients which increased foliar macro and micronutrients for good sustainable palm growth.

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