

The manipulation of microbials such as fungi, bacteria, mycorrhiza and actinomycetes as biocontrol agents (BCAs) is being investigated to control *Ganoderma*, the causal agent of basal stem rot (BSR) disease of oil palm. The biological properties of several antagonistic fungi, namely, *Trichoderma* (Sariah and Zakaria, 2000; Izzati and Abdullah, 2008; Shamala and Idris, 2009), *Aspergillus* (Shukla and Uniyal, 1989) and *Penicillium* (Dharmaputra *et al.*, 1989), have been studied and proven to be antagonistic against *Ganoderma boninense*. *Burkholderia cepacia* and *Pseudomonas aeruginosa* are endophytic bacteria isolated from symptomless oil palm root tissues. They have been shown to have potential in inhibiting the growth of *G. boninense* (Zaiton *et al.*, 2008). An endophytic fungus is defined as an organism that lives in association with plants for most, if not all, of its life cycle. Such an organism lives within the intercellular spaces of plants, where it lives off apoplastic nutrients. Potential endophytic fungi were investigated through *in vitro* and nursery studies against *G. boninense*.

## ISOLATION AND *in vitro* SCREENING OF ENDOPHYTIC FUNGI AGAINST *Ganoderma boninense*

A total of 500 endophytic fungi were isolated from trunk and root tissues of oil palms, and were extensively screened to evaluate their biocontrol activity against *G. boninense*. Based on the dual

culture assay, 456 isolates gave a percentage inhibition of radial growth (PIRG) value against *G. boninense* of less than 40%, 35 isolates gave a PIRG value of 40%-80%, and nine isolates with PIRG values of more than 80%. By using a liquid culture assay, 14 isolates gave percentage of mycelial dry weight (PMDW) values of 40%-80%. GanoEF1 gave the best results in inhibiting *G. boninense* in both bioassays (Figures 1 and 2).

## NURSERY EVALUATION OF GanoEF1 AGAINST *G. boninense*

Based on two nursery trials, seedlings treated with GanoEF1 showed a significant lower percentage disease incidence (%DI) six months after treatment (Figure 3). Disease development was assessed using the percentage severity of foliar symptoms (%SFS). Both trials indicated significant differences between seedlings treated with GanoEF1 and untreated seedlings six months after inoculation with *G. boninense* (Figure 4). Untreated seedlings showed the highest percentage of dead seedlings which was significantly different from seedlings treated with GanoEF1 (Figures 5 and 6). Seedlings treated with GanoEF1 gave the lowest area under the disease progress curve (AUDPC) of 113.34 and 100.01 in Trials 1 and 2, respectively, compared to untreated seedlings (control), with AUDPC of 180.0 and 193.34, respectively (Table 1). Overall between 37.0% to 55.17% of BSR disease incidence was reduced in seedlings treated with GanoEF1.

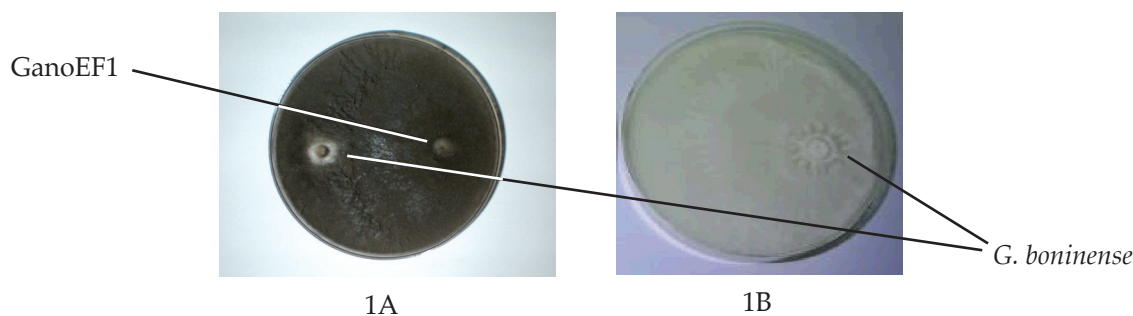


Figure 1. Dual culture assay. Note: *G. boninense* inhibited by GanoEF1 (1A) and *G. boninense* in control plate (1B).

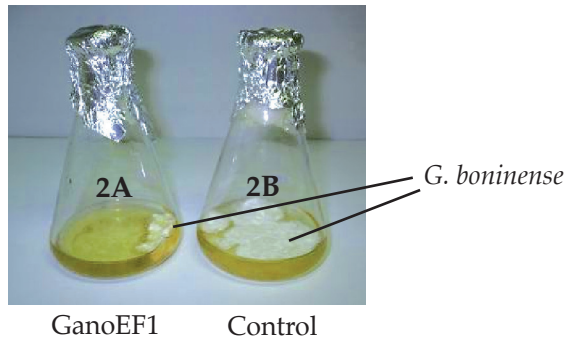


Figure 2. Liquid culture assay. Note: *G. boninense* inhibited by *GanoEF1* filtrate (2A) and *G. boninense* in control filtrate (2B).

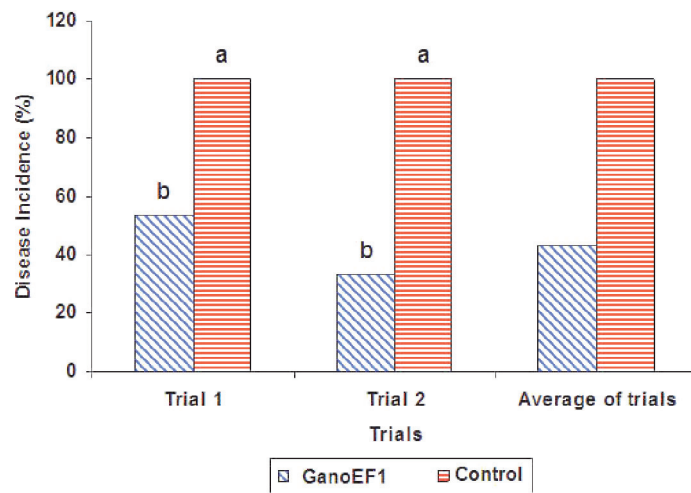


Figure 3. Percentage of disease incidence (%DI) of seedlings due to *G. boninense* infection. Means with the same letter within a trial denote no significant difference based on the Least Significant Difference (LSD) test at  $p=0.05$ .

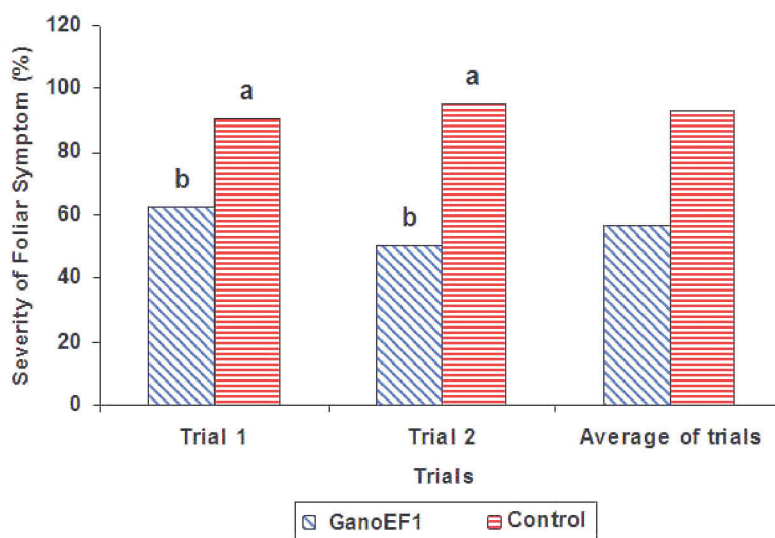


Figure 4. Percentage severity of foliar symptoms (%SFS) of seedlings due to *G. boninense* infection. Means with the same letter within a trial denote no significant difference based on the Least Significant Difference (LSD) test at  $p=0.05$ .

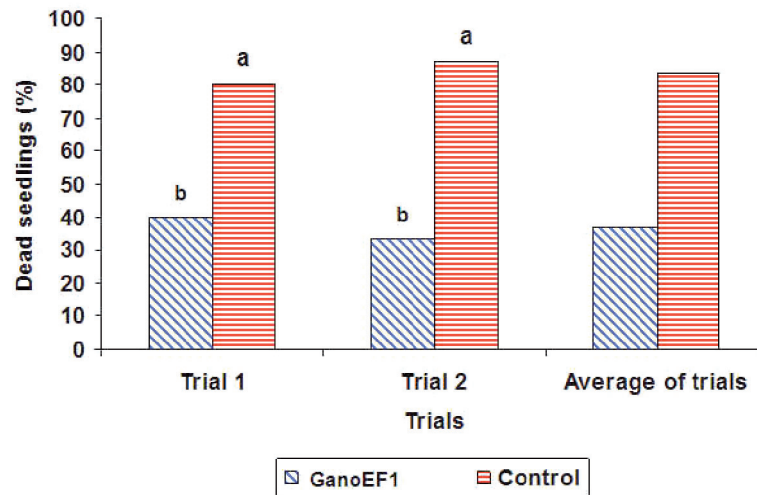


Figure 5. Dead seedlings (%) due to *G. boninense* infection. Means with the same letter within a trial denote no significant difference based on the Least Significant Difference (LSD) test at  $p=0.05$ .

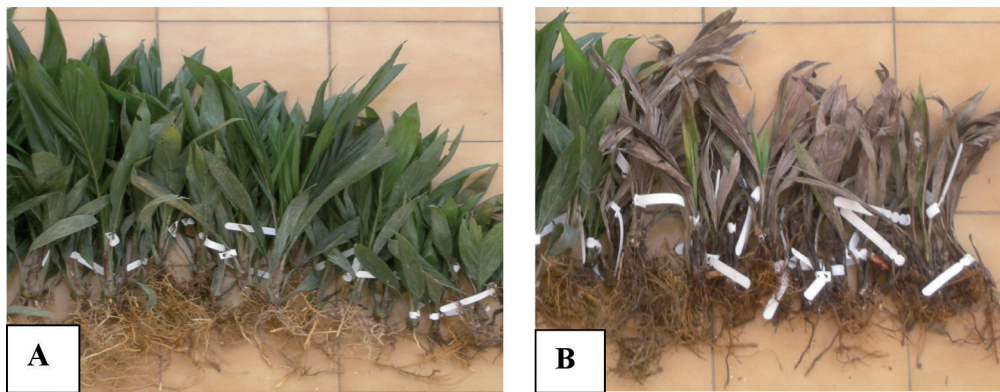


Figure 6. Oil palm seedlings treated with GanoEF1 and artificially inoculated with *G. boninense* (A), and seedlings untreated with GanoEF1 and inoculated with *G. boninense* (control) (B).

**TABLE 1. EFFECT OF GanoEF1 ON BASAL STEM ROT (BSR) DISEASE DEVELOPMENT IN OIL PALM SEEDLINGS AT SIX MONTHS AFTER TREATMENT**

Treatment	Nursery Trial 1		Nursery Trial 2	
	AUDPC <sup>1</sup>	DR <sup>2</sup> (%)	AUDPC <sup>1</sup>	DR <sup>2</sup> (%)
Seedlings untreated with endophytic fungus + inoculated with <i>G. boninense</i> (control)	180.0	-	193.34	-
Seedlings treated with GanoEF1 + inoculated with <i>G. boninense</i> (T1)	113.34	37.03	86.67	55.17

Note: <sup>1</sup>Area under disease progress curve (AUDPC). <sup>2</sup>Disease reduction (DR).  
Average disease/reduction (DR) = 46.1%.

## CONCLUSION

GanoEF1 has the potential of inhibiting the growth of *G. boninense* *in vitro*. In addition, GanoEF1 is effective in suppressing *G. boninense* infection in oil palm seedlings. Field evaluation is being conducted to confirm the efficacy of GanoEF1 as biocontrol agents against *Ganoderma* in oil palm.

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