
Integrated *Ganoderma* Management in Oil Palm Plantations*

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Among the major devastating oil palm diseases, basal stem rot (BSR) or *Ganoderma* is widespread and occurring in the major oil palm producing regions of the world, especially in Malaysia and Indonesia. In Malaysia, the BSR disease is having a severe impact on oil palm production in Peninsular and is currently increasing in intensity in Sabah and Sarawak. Incidence of BSR disease in Malaysian oil palm estates was 3.71 per cent (59,148 ha out of 1.594 million ha surveyed). Whereas, in oil palm smallholders, BSR disease incidence was 9.24 per cent and affected area was 3,450.7 hectares (out of 37,359.8 ha surveyed). The Integrated *Ganoderma* Management (IGM) which includes sanitation, biological agents, fertiliser with beneficial/trace elements and chemical control was strongly suggested to control BSR disease in existing planting and at replanting. Some BSR disease control methods in existing plantings and at replanting have been achieved and are being implemented in several oil palm plantations and smallholdings. MPOB has launched the standard operating procedure (SOP) guidelines to control *Ganoderma* as part of an awareness campaign to manage and mitigate this disease more effectively. As preventive treatment, two commercial products of biocontrol agent, namely biofertiliser *Hendersonia GanoEF1* (endophytic fungus, powder formulation) and biofertiliser *Streptomyces GanoSA1* (soil actinomycete, powder formulation), incorporated into organic materials have been successfully produced. Other products, fertiliser organic and fertiliser chemical OCSpecial containing beneficial/trace elements for controlling *Ganoderma* disease also have been commercially produced. The product can be applied in seedlings, planting hole and planting palms. The use of these products can be contributed positively towards controlling and prevention of the *Ganoderma* disease in oil palm. Some control technologies and preventive treatment developed towards IGM and its proven potential in increasing productivity in oil palm is discussed.

Keywords: *Ganoderma*, biological control, trace elements, oil palm.

Palm oil is an important commodity in Southeast Asia (SEA) especially to the world's two largest palm oil producing countries, Malaysia and Indonesia. Being a major economic crop in this region and other parts of the world, the awareness, detection, control and management of oil palm diseases are becoming of great importance. There are many diseases of oil palm found in the producing countries. The most

important oil palm diseases are vascular wilt caused by *Fusarium oxysporum* f. sp. *elaeidis*, basal stem rot (*Ganoderma* spp.), red ring (*Rhadinaphelenchus cocophilus*), sudden wilt (*Phytophthora staheli*) and bud rot (*Phytophthora palmivora*) (Turner & Gillbank, 2003; Idris, 2011 a & b). In South East Asia (SEA), basal stem rot (BSR) or *Ganoderma* disease caused by species of

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Ganoderma fungus, is the only pathogenic disease causing serious losses of field planting, especially in Malaysia and Indonesia (Idris, 2009; Susanto, 2009). The disease is also recorded in Africa, Central America and Papua New Guinea (Turner & Gillbank, 2003). The threat of *Ganoderma* to the oil palm industry in Malaysia warrants new and more aggressive approaches in finding solution to the control of the disease. The disease usually becomes worse with successive generation of oil palm planted on the same land. Until 2016, the Malaysian Palm Oil Board (MPOB) has over the years developed and disseminated 33 technologies on *Ganoderma* research related to the biology, early detection, control and management of *Ganoderma* for the advantage of oil palm industry. These technologies have been disseminated to the oil palm industry members through the seminars, field demonstrations and hands-on training. This paper presents some control technologies and commercial products as preventive treatment towards Integrated *Ganoderma* Management (IGM) and its proven potential in increasing productivity in oil palm.

BASAL STEM ROT DISEASE

The basal stem rot (BSR) or *Ganoderma* disease was recorded on oil palm planted in Peninsular Malaysia (Khairudin & Chong, 2008), Sabah (Hoong, 2007; Walat & Hoong, 2011) and Sarawak (Mohd Rakib *et al.*, 2014). MPOB has conducted a survey to obtain more information on status of the BSR disease incidence in Malaysian estates in cooperation with major oil palm agencies including plantation groups, government agencies and independent estates. A total of 1,061 (45.0%) out of 2,356 estates have responded to the survey with the total areas of over 1.594 million hectares. Only

632 (59.57%) out of 1,061 estates reported the presence of BSR disease (Idris *et al.*, 2011a). The incidence of BSR disease in Malaysian estates was 3.71 per cent (59,148 ha out of 1.594 million ha surveyed). A survey on status of BSR disease in oil palm planted by smallholder participants of *Tanam Semula Sawit Pekebun Kecil* (TSSPK) also was carried out by MPOB. The survey presented the incidence of BSR disease in Malaysia, including the Peninsular, Sabah and Sarawak. A total of 10,292 smallholders was visited with the total areas of 37,359.81 hectares. The total area affected with BSR disease planted by oil palm smallholders was 3,450.70 hectares (out of 37,359.81 ha surveyed) and BSR disease incidence was 9.24 per cent (Mohd Shukri *et al.*, 2015). Johor had the highest *Ganoderma* disease area with 1,032.97 hectares, followed by Sabah (930.85 ha), Perak (718.49 ha), Selangor (407.08 ha), Sarawak (135.0 ha), Negeri Sembilan (114.6 ha), other states less than 40 hectares and none in Kelantan and Kedah. Out of 10,292 smallholders surveyed, 1,528 (14.85%) smallholders were reported the presence of BSR disease. The highest number of smallholders with BSR disease was in Johor (487), Perak (410), Selangor (202), Sabah (252), Negeri Sembilan (70), Sarawak (55), Pahang (24), Terengganu (14), Pulau Pinang (11) and other states less than five smallholders or none. Four species of *Ganoderma* (*G. boninense*, *G. zonatum*, *G. miniatocinctum* and *G. tornatum*) have been identified to be associated with the BSR disease. The first three species were proved pathogenic to oil palm, while *G. tornatum* was not pathogenic. Studies have confirmed that *Ganoderma* fungus can caused BSR and upper stem rot (USR) diseases in Malaysia (Idris, 2012; Mohd Rakib *et al.*, 2014).

INTEGRATED *GANODERMA* MANAGEMENT (IGM) STRATEGIES

MPOB has introduced the Integrated *Ganoderma* Management (IGM) to find solution to the control of the disease which includes sanitation, biological agents, fertiliser with beneficial/trace nutrient elements and chemical control. These control measures are aimed at minimising disease incidence in replanting, prolonging the productive life of the infected palm, and delaying the progress of *Ganoderma* infection. In 2016, MPOB launched the standard operating procedure (SOP) guidelines to control *Ganoderma* as part of an awareness campaign to manage and mitigate this disease more effectively (Idris *et al.*, 2016). Some BSR disease control methods in existing plantings and management strategies at replanting have been achieved and are being implemented in several oil palm plantations and smallholders in Malaysia (Idris *et al.*, 2011b).

In existing plantings

In existing plantings, the inoculum of *Ganoderma* can be reduced significantly by removal (destroying) of the diseased palm using excavator/backhoe. This involves the removal or excavating (destroying) of diseased roots, stump and trunk of infected oil palm. Removal of diseased palm by excavating the soil, stump and root masses with a size of 2 m length x 2 m width x 1.5 m depth and refilling with nearby soil is recommended (Idris *et al.*, 2005). In Sime Darby plantations, diseased palm less than 5 years old is excavated with the resulting cavity of the size of 2 x 2 x 1.5 m to ensure the remains of diseased bole tissues and the major part of the root system are removed (Khairudin & Chong, 2008). However, in plantings older than 5 years old, it is recommended that diseased productive palms (healthy-looking) are

retained and removed as soon as they no longer provide economic returns. A soil fumigant, dazomet could also effectively eradicate *Ganoderma* inoculum within infected stumps (Idris & Maizatul, 2012). Studies indicate that dazomet moved into the infected stump and caused death of *Ganoderma* fungus. A fungicide, hexaconazole applied as trunk injection can be used as curative treatment or for prolonging the productive life of *Ganoderma*-infected palms (Idris *et al.*, 2004b). It was reported that 74.4 per cent of infected palms treated with hexaconazole (4.5 g active ingredient or 90 ml per palm) dissolved in 7 litres of water were still alive and producing fruit bunches (Idris, 2012).

At replanting

Correct technique of land preparation at the time of oil palm replanting is regarded as an important practice for controlling of BSR. At replanting, underplanting of oil palm either following coconuts or oil palm is strongly not recommended, especially in *Ganoderma* infected areas. Monitoring the effect of underplanting adopted by oil palm estates (oil palm with oil palm) and smallholders (oil palm with coconut) at replanting on BSR disease incidence in replanted palms was conducted. Ground BSR census was carried out in each of the study site involved. High BSR disease incidence (>30%) was recorded in replanted palms either oil palm with oil palm or oil palm with coconut (Idris, 2012). Sanitation by destroying (removal) of the old palms involving pushing over of the old stand, shredding/chipping into small fragments, excavating roots masses and stumps with a size of 2 m length x 2 m width x 1.5 m depth, ploughing the new replanting row and planting new palms along the ploughing areas is highly recommended (Idris *et al.*, 2004a). By adopting this

technology, incidence of *Ganoderma* disease on replanted palms could be reduced to 30.8 per cent at 15 years of planting (Idris, 2012).

PREVENTIVE TREATMENT

Collaboration research between MPOB, university and private companies in biological agents and fertiliser with beneficial/trace elements as preventive treatment for controlling of *Ganoderma* disease has led to the development of new innovations, techniques and product formulations. Until now, three commercial products are available in the market and is ready to be used by the oil palm industry as preventive treatment for *Ganoderma* control.

Biofertiliser *Hendersonia GanoEF1*

Endophytic microorganisms were chosen for the selection of suitable biocontrol agent of BSR disease because they colonise plant tissues internally and their movement is within the plant system, thus providing holistic control and often being unaffected by environment changes. MPOB has signed an agreement with All Cosmos Industries Sdn. Bhd., Johor, Malaysia for joint Research and Development (R&D)

to develop a biofertiliser *Hendersonia GanoEF1* powder that contains endophytic fungus, *Hendersonia toruloidea* GanoEF1 incorporated with organic materials (Figure 1). The *Hendersonia GanoEF1* has been found strongly antagonistic against *Ganoderma* in various laboratory and nursery studies. The *Hendersonia GanoEF1* fungus colonises in oil palm roots and does no harm to the host plant. Using the biofertiliser *Hendersonia GanoEF1*, the incidence of *Ganoderma* disease in oil palm seedlings has been proven to reduce by up to 69.5 per cent (Idris *et al.*, 2012). The formulation of *Hendersonia GanoEF1* has been patented and now is ready for commercial production. In a field study, 4.9 per cent of palms treated with the biofertiliser showing symptoms of BSR disease and died due to *Ganoderma* infection compared to the untreated palms with a casualty rate of 83.3 per cent (Nurrashyeda *et al.*, 2015). Studies indicated the potential of the biofertiliser *Hendersonia GanoEF1* for the ability to prevent *Ganoderma* infection in oil palm.

Biofertiliser *Streptomyces GanoSA1*

The actinomycetes have the ability to effectively suppress many plant diseases. *In vitro* studies

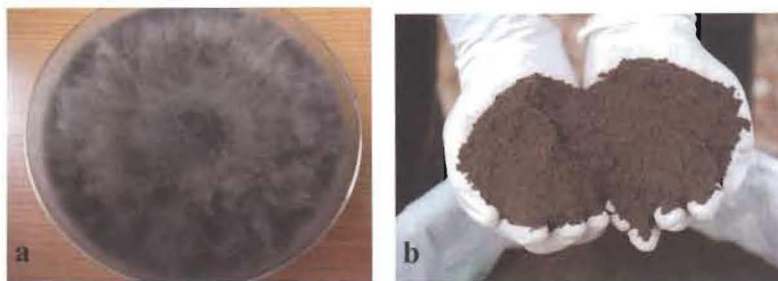


Figure 1 Biofertiliser *Hendersonia GanoEF1*. Pure culture of *Hendersonia GanoEF1*, endophytic fungus (a) and powder formulation of *Hendersonia GanoEF1* incorporated with powdered empty fruit bunches (EFB) (b)

identified that *Streptomyces nigrogriseolus* GanoSA1, a soil actinomycete, has potential as biological control agent (BCA) against *Ganoderma* disease (Shariffah *et al.*, 2015 a & b). With joint research and development (R&D) with Pascal Biotech Sdn. Bhd., Selangor, Malaysia, *Streptomyces* was developed onto a dry formulation powder, namely biofertiliser *Streptomyces* GanoSA1 (Figure 2). Investigations of the effect of the product in controlling *Ganoderma* disease and growth of oil palm seedlings was conducted in nursery and field. Two treatments were involved: i.e. seedlings untreated with the product (T1, control) and seedlings treated with the product (T2). Vegetative growth results indicated that seedlings treated with the product containing *Streptomyces* gave positive effect on frond height, number of leaves and chlorophyll content without harm to the growth of oil palm seedlings. The effectiveness to suppress the development of *Ganoderma* infection in oil palm was studied in nursery by artificial inoculation using rubber wood block (RWB) sitting method. Nursery trial showed that seedlings treated with the product had lower dead seedlings of 43.3 per cent as compared to the un-treated seedlings of

73.3 per cent (Idris *et al.*, 2014a). For field study, 6.6 per cent of palms treated with the product showed symptoms of BSR disease and died due to *Ganoderma* infection compared to the untreated palms of 75.0 per cent (Shariffah *et al.*, 2015a). Mass production process of the biofertiliser *Streptomyces* GanoSA1 powder was established and patented.

Organic and chemical fertiliser with beneficial/trace nutrient elements

Plant nutrients are primary components for disease control in many crops. It was reported that calcium nitrate suppressed BSR symptoms on clonal materials (Sariah & Zakaria, 2000). The importance of applications of balanced nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulphur (S), iron (Fe), manganese (Mn), copper (Cu) and boron (B) are critical available nutrients for oil palm and so incorporating these elements in fertilisers may prevent *Ganoderma* attack (Mohd Tayeb *et al.*, 2003; Singh, 1991). Beneficial nutrient elements have positive effects on growth development, yield and disease resistance, which have been observed in a wide variety of plant species. The effects



Figure 2 Biofertiliser *Streptomyces* GanoSA1. Pure culture of *Streptomyces* GanoSA1, soil actinomycetes (a) and powder formulation of *Streptomyces* GanoSA1 incorporated with vermiculite and biocharcoal (b).

of beneficial elements are mainly associated with its high level of deposition in plant tissues, therefore enhancing their strength and rigidity (Hanafi *et al.*, 2014). Beneficial elements also have potential in enhancing host resistance to plant diseases by stimulating defense reaction mechanisms. The specific organic fertiliser has been developed using organic material and fertiliser with beneficial/trace nutrient elements such as iron, manganese, copper and silicon in reducing risk of *Ganoderma* in oil palm (Idris *et al.*, 2014b). With further R&D, between MPOB, Universiti Putra Malaysia (UPM) and FELCRA Plantation Services Sdn. Bhd., Kuala Lumpur, Malaysia, had successfully produced new fertiliser formulations, namely fertiliser organic and fertiliser chemical OCSpecial. (Figure 3). These new formulations are used mainly for the prevention of *Ganoderma* disease, growth of oil palm and improve soil fertility (Idris *et al.*, 2015). This formulation contains N, P, K and Mg; powdered empty fruit bunches (EFB) and beneficial/trace nutrient elements. Four fertiliser chemical OCSpecial formulations were developed; they are for seedlings in nursery and three formulations for field palms. Mass production process of these formulations was established and patented. The effectiveness of the formulation to control the disease development of BSR disease oil palm was studied in nursery

and field trials. Nursery trial indicated seedlings treated with the formulation has lower seedling casualty of 36.0 per cent as compared to the untreated seedlings loss of 90.0 per cent. For field study, 4.7 per cent of palms treated with the formulations showed symptoms of BSR disease and died due to *Ganoderma* infection compared to the untreated palms loss of 83.3 per cent. This study indicated the potential of the fertiliser formulation with beneficial nutrient elements for the ability to prevent *Ganoderma* infection in oil palm.

CONCLUSION

The basal stem rot or *Ganoderma* disease can be managed more effectively with the Integrated *Ganoderma* Management, which includes sanitation, biological aspects, using fertiliser with beneficial/trace elements and chemical control. Some BSR disease control in existing plantings and management strategies at replanting have been achieved and implemented in Malaysia. As preventive treatment, three commercial products, namely biofertiliser *Hendersonia GanoEF1* (endophytic fungus) and biofertiliser *Streptomyces GanoSA1* (soil actinomycete), and a fertiliser with beneficial/trace elements (organic and chemical OCSpecial) for controlling *Ganoderma* disease have been



Figure 3 Organic fertiliser (a) and chemical fertiliser OCSpecial with beneficial nutrient elements

produced. The product can be applied in seedlings, planting hole and infield planting of palms. The use of these products can contribute positively towards controlling and prevention of the *Ganoderma* disease in oil palm plantation. It is hoped that efforts in these areas would ensure better *Ganoderma* disease management for a long-term and sustainable control of diseases in oil palm.

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