Conceptual Design of an Applicator for Nano-Solution in the Treatment of G. boninese Infected Oil Palm Tree

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***Abstract— G. boninense* causes both basal stem rot (BSR) and upper stem rot (USR) and remains as South East Asia's most devastating oil palm diseases with direct loss of the stand, reduced yield of diseased palms and the resultant requirement for earlier replanting. Although it has been clearly identified as the main cause of the disease in oil palms, strategies for the early detection and control of *G. boninense* are still immature. With all the drawbacks mention above, an integrated smart sensing system is vital for future sustainability of palm oil industry. This paper describes the conceptual design of an applicator for a nanodelivery system in actual plantation.**

Keywords—Design; Applicator; Nanodelivery; G. boninese; drilling-injecting.

I. INTRODUCTION

Basal Stem Rot (BSR) has been recognized as a major disease in oil palm trees that instigated tremendous loses in palm oil production [1]. Studies indicate that the disease is caused by fungi. Among the fungi, Ganoderma boninense (*G. boninense*) has been identified as the most aggressive pathogen [2]. Generally, the severity of infection can be classified into four stages, whereas stage one is considered as the early stage and curable, stage four is the worst case. Early detection of *G. boninense* infection is of prime importance. Currently, a number of detection and treatment techniques have been tried with various level of success. In terms of treatment, the MPOB has come up with an acceptable solution based on hexaconazol and or tetraconazol. At this stage a novel attempt is in progress in order to convert the solution into nanoparticles.

Enveloped within the needs to control the disease is the development of an applicator for the optimized nanocarrier embedded with nanosensor in actual plantation. In smart farming, deliverance of fertilizer, pesticide, or other chemical substances are according to site specific. This practice optimizes the need of specific region while reducing the cost of materials application. On the implementation of nanodelivery system and embedded nanosensor in actual plantation, the challenge goes beyond the capability of the existing variable rate technology (VRT) applicator. The new nanoapplicator will be responsible in the deployment of the nanocarriers to the infected region, in which the spores may exist within the soil, the roots or the trunk. A robust injector type device will be needed that is able to penetrate various surface hardness of the infected region. Current research on nano or micro injectors for biological systems concentrates on the methods to penetrate living cells. Gordon et al., (1980)[3] had initiated a method called microinjection which was applied to infuse foreign DNA into a fertilized mouse zygote. Others have emulated the basic concept with further improvements such as microrobotics, feedback controls, and development in micro needles. The main issue being highlighted is the rate of mortality of the living cells upon manipulation. Aten et al., (2014) reported on the design of a novel nanoinjector that applied electrically charged injector rather that a syringe-pump design to insert foreign DNA into mouse zygotes. In chemistry application, nanoinjectors are employed in precision dispensation whereas delivery of substances within nano to pico liters are needed as described in [4] and [5].

In general, the focus of this project will be on the implementation of the nanodelivery system. This paper discusses the development of a design concept of drilling and injecting oil palm trees for optimum delivery of fungicide specifically to kill Ganoderma boninense.

II. MATERIALS AND METHODS

A. Study on current system

Existing method was studied. Tetraconazol or Hezaconazol is applied to the infected trees in order to kill fungus by injecting the solution at the target zone (1 ft from the ground) [6], [7], [8], [9]. Basic equipment are (1) Drill and (2) Injector (Fig. 1). First the tree is be drilled, then an injector is inserted into the hole to deliver the solution, either applied using a personal equipment or carried by a tractor.

Fig. 1. Currently used injection system

B. Proposed New System

A new system would integrate both drilling and injecting in one pass. Iniatial concept was developed in CAD in order to analyze the practicability of the system.

III. RESULTS AND DISCUSSION

A. Combined Drill-Injection

Upon study of the current method, a combination of drilling and injecting device was proposed. The initial concept was developed in CAD. The entire device would consist of a curve plate to hold the drill-injector firmly to the trunk. There are two handlebars for an operator to hold and an LCD display will be used to display information such as drilling depth and volume of injection. The current concept was meant for independent manual usage. A movable carriage will be used to carry the tank with a capacity of 35 L. This value was chosen on the assumption that in one treatment, 7 L are required, therefore with this capacity five trees can be treated in one pass. The general concept is shown in Fig. 2 and Fig. 3.

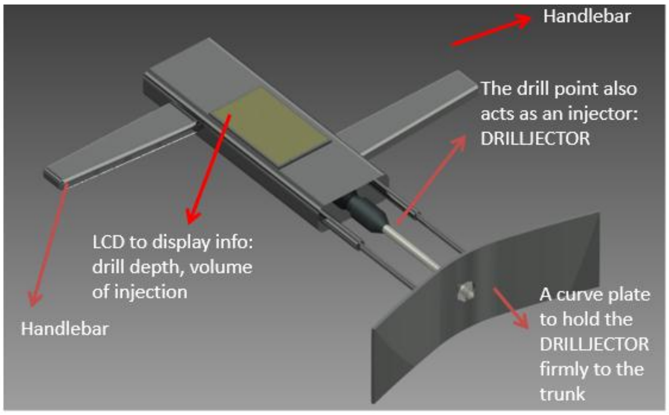

Fig. 2. Conceptual design of a drill-injection system

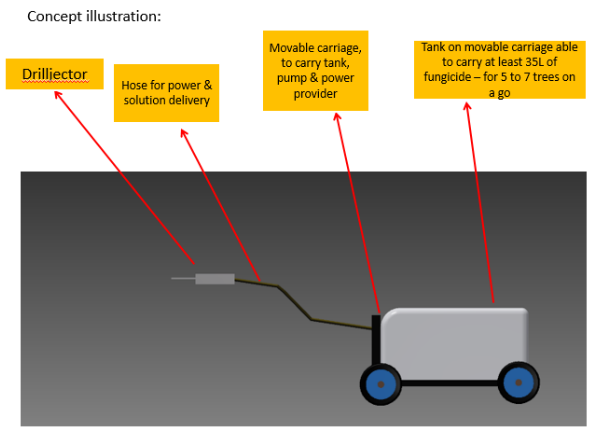

Fig. 3. General device concept

B. Design of Nozzle

The nozzle design should enable both drilling and injecting. The critical part was on the type of aperture to be used because it should be able to close while drilling and open as wide as possible for injecting. The initial concepts for nozzle designs are illustrated in Fig. 4 and Fig. 5.

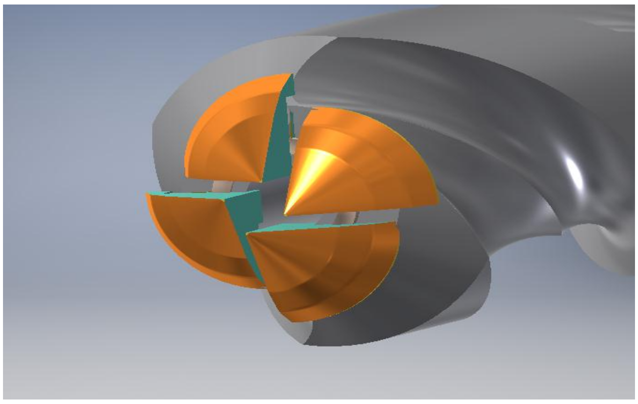

Fig. 4. Iris type aperture

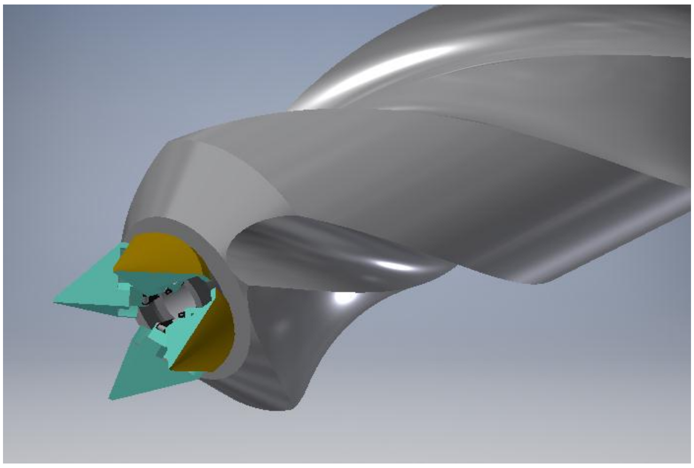

Fig. 5. Clamp type aperture

IV. CONCLUSIONS

This paper presents the conceptual design of a drill-injection applicator device for delivery of nano-solution for treatment of G. boninense infected oil palm trees. The concept considers combining both drilling and injecting in one pass in order to simplify the procedures for field works.

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