TRACTOR MOUNTED TRUNK INJECTOR FOR CONTROL OF BASAL STEM ROT (BSR) DISEASE

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The basal stem rot (BSR) disease in oil palm is caused by the wood decaying fungi, *Ganoderma boninense* (*Figure 1*). It is a serious disease especially in the replanted areas from old oil palm and coconut and remain as a major disease of oil palm in South-east Asia. *Ganoderma* produces enzymes that degrade the oil palm tissue which causes problems to the uptake of water and other nutrients to the upper parts of the palm tree (Idris *et al.*, 2003).

Based on the 2009-2010 BSR survey of oil palm estates, about 3.71% incidence of disease was reported (or 59 148 ha out of 1 594 286 ha). For smallholders, a BSR ground survey was conducted in 2011-2013 for oil palms of more than 25 years. About 8.05% (or 2 744.96 ha out 34 067.88 ha) of BSR disease incidence was recorded.

One of the methods to control this disease in the field is by injecting chemical into the affected palms. The conventional injecting equipment in the market are powered tools, which are heavy to carry, therefore affecting worker's productivity. Using this tool, it takes 20 min to complete an operation cycle which includes drilling a hole in the palm trunk and injecting the chemical into the drilled hole.

This tractor mounted trunk injection equipment is developed to offer a faster method of injecting fungicides into the oil palm trunk.

Figure 1. Ganoderma boninense.

DESCRIPTION OF TECHNOLOGY

The new method offers a faster and non-arduous task of applying chemical into the palm trunk. The equipment consists of a hydraulic driven drilling and injecting mechanism, with the two main components mounted to the front part of a mini tractor. The whole operation of drilling until chemical injection is controlled from the driver's seat. The movement of the equipment would be deployed by a combination of a mechanical and hydraulic system which requires only one operator. The specification of the mini tractor is as in *Table 1*.

TABLE 1. SPECIFICATION OF THE TRACTOR AND INJECTOR

Specification of tractor	
Model	Compact Utility Tractor Kubota B2710
Engine	Kubota 1.3L 4-cyl diesel, 27 hp
Weight	789 kg
Wheelbase	166 cm
Front tyre	7 – 12
Rear tyre	12.4 – 16
Specification of the injector equipment	
Drill diameter	11 mm
Drill length	240 mm
Injector diameter	12 mm
Total injector length	372.25 mm
Max water pressure	20 bar pressure
Capacity	200 litres capacity fibreglass tank mounted

The Prototype

Figure 2 shows the prototype of the equipment mounted on a tractor. It comprises of a drill, injector, moving platform, hydraulic cylinder, hydraulic motor and its system. *Figure 3* shows the main component of this machine.

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Figure 2. The prototype.

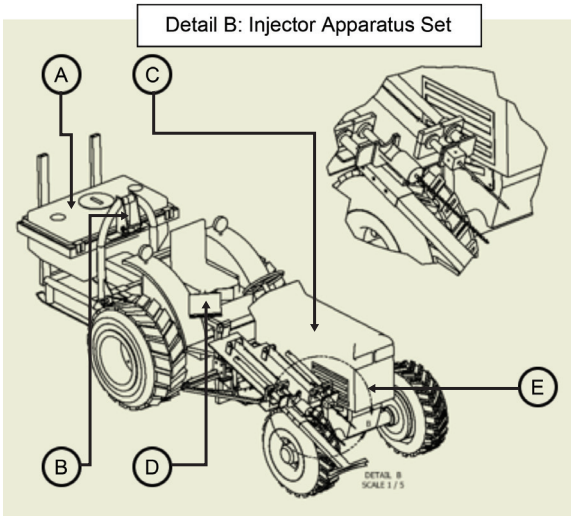

Figure 3. Main components of the prototype.

No.	Part
A	200 litres capacity fibreglass tank
B	Volume meter
C	Mini tractor
D	Hydraulic control
E	Injector apparatus

Drill Bit and Injector Design

The drill bit is designed to have a threaded length from the middle towards its tip while the other end is a round bar. The length and diameter of the drill bit are 450 mm and 11 mm, respectively with a thread's length of 220 mm. The drill bit is made of high-carbon steel for heavy duty work.

The injector is made of stainless steel with length and diameter of 390 mm and 12 mm, respectively. It is important for the diameter of the injector to be slightly bigger than the drill bit, to fit the nozzle tightly into the trunk thus preventing the injected chemical from gushing out during the high pressure injection process (*Figure 4*).

Operation Procedures

In the operation, a hole will be drilled into the palm trunk. Once completed, the nozzle will be pushed into the hole and subsequently the specific amount of chemical will be injected into the trunk (*Figure 5*).

Figure 4. Injecting nozzle and the drill mounted on the platform.

During the injection process, the chemical from the tank is pumped through the hose and channelled into the nozzle. The amount of fluid passing through is measured by the volume-meter, while the pressure gauge measures the operating pressure in the system.

Figure 5. Trunk injection operation.

Performance Test

The performance of the machine was studied by injecting different volumes of eosin dye solution into healthy oil palm. The injection pressure was set at approximately 20 bars to ensure that the pressure is within the limit while at the same time avoids the dye solution from gushing out. Three treatments of different volumes were evaluated, *viz.* 3, 4, and 5 litres of dye solution on three different palms. Immediately after the injection, the palm was felled and cut into two halves, *i.e.* along its longitudinal and cross-section axis (*Figure 6*). The distribution profile of the dye in the palm trunk on each axis were recorded, *i.e.* the vertical and horizontal movement.

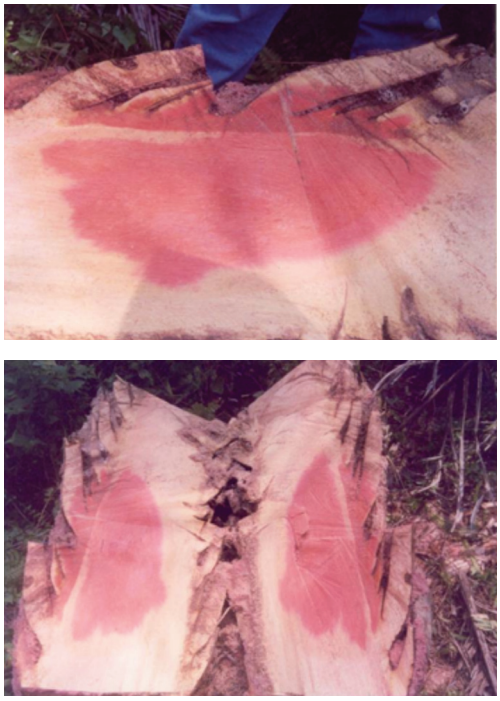

Figure 6. Dye distribution profile in the stem.

FUNCTIONAL TEST AND FIELD TRIAL

The machine was evaluated at the MPOB Research Station in Kluang. The trial site was an area of 100 ha with 12-year old palms, some having infected with *Ganoderma*.

In this trial, 90 ml of hexaconazole was diluted into 10 litres of water, as recommended for *Ganoderma* control. The injection pressure was set at 20 bars to ensure wider distribution of the chemical in the cross-section and the longitudinal axis of the palm trunks. The time taken to complete the operation was recorded.

The machine was capable of injecting the 10-litre chemical solution at only 2.5 min per palm (*Figures 7* and *8*). This total time taken is inclusive of drilling the hole, positioning/adjusting injector into the drilled hole, injecting the chemical and moving the machine to the next palm. It was found

Figure 8. The drilling and injecting process.

that the machine is able to complete between 100 – 120 palms a day.

ECONOMIC ANALYSIS

The fixed costs include the mini tractor and injector set while variable costs are labour, fuel and lubrication, repair and maintenance. The operational cost per palm was calculated using a straight-line depreciation method. The details of the calculation are shown in *Tables 2* and *3*.

Assumption		
Apparatus's life span	:	five years
Performance	:	100 palms per day
Labour cost	:	RM 50 per day

TABLE 2. TOTAL CAPITAL COST OF APPARATUS (including prime mover – mini tractor)

No.	Description	Cost (RM)
1	Injector	300
2	Drill	200
3	Hydraulic system	3 000
4	Hydraulic table	1 000
5	Fibre-glass tank	2 000
	Total	6 500
6	Mini tractor	50 000
	Grand total	56 500

Figure 7. The tractor mounted trunk injector at work.

TABLE 3. COST ANALYSIS OF APPARATUS INCLUDING MINI TRACTOR USING STRAIGHT LINE DEPRECIATION

Description	Calculation	Cost (RM per day)
Depreciation [price/(life span x 12 month x 23 days)]	56 500/(5 yr x	40.94
Fuel (diesel) @ 15 litres per day	15 x RM 2 litre^{-1}	30
R&M cost @ 10% per year of purchase price	10% x 56 500 / (12 months x 23 days)	20.47
Lubrication cost @ 10% of R&M	10% x 20.47	2.05
Labour cost		50
Total		143.46
Cost per palm = total cost/productivity per year	RM 143.46 per day/100 palms per day	1.43

Table 3 shows that the operational cost per palm (excluding chemical cost) is RM 1.43 per day. The cost is based on the use of a mini tractor as the prime mover which can be reduced if a smaller prime mover is used, such as a three-wheeler transporter with a price range of between RM 15 000 to RM 20 000 per unit.

CONCLUSION

The developed machine is capable of injecting chemical into the palm tissues effectively. Using a dye solution, it was demonstrated that this machine provides a widespread distribution profile in the oil palm stem. In the actual field application where hexaconozole was used to control *Ganoderma*, the machine took between 2.5 min to complete the task, covering between 100 to 120 palms per day.

With this machine, operator fatigue is eliminated. The number of workers was reduced with a reasonable operational cost of RM 1.43 per palm.

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