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Fertilization with copper and zinc to reduce the impact of *Ganoderma* infection in oil palm plantation

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Introduction

- Total oil palm area in Malaysia is 5.392 million ha as of December 2014 (MPOB, 2015)
- Oil palm in Malaysia is currently in the 3rd generation of planting
- Main nutrients added as fertilizers were N, P, K, Mg, & B
- Main disease causing reduction in yield is Basal stem rot caused by *Ganoderma boninensis*

- The disease was first diagnosed in 1931. At the time, only old palms were infected. But nowadays, palms as old as 1-2 years old have been detected with this disease.
- Yield losses of up to 46% have been recorded

Methods to control the disease:

- Soil mounding
- Surgery
- Fungicide injection
- Isolation trenching
- Resistant plant materials
- Proper fertilizer application

Infected palm



Serious infection





Use of micronutrients

- Boron is used routinely
- Cu and Zn are used mainly on palms grown on organic soil – very few done on mineral soils
- Cu has reported to be involved in:
 - enhancement of peroxidase in rice leaves (Wei *et al.*, 2000)
 - lignin biosynthesis in soybean roots (Chih *et al.*, 2005)
 - enhancement of peroxidase activity and lignin content in *Raphanus* (Chen *et al.*, 2002).

- Lignin is a complex aromatic polymer, which is deposited in the secondary cell walls of all vascular plants (Frei, 2013)
- Lignins chemical properties are believed to improve the cell wall's efficiency as a barrier against biotic and abiotic stresses, especially microbial attack (Baucher *et al.*, 1998).
- Lignin have commonly been attributed to:
 - increasing cell wall rigidity and hydrophobicity
 - improving the plant's pathogenic defense

(Glasser, 1980; Higuchi, 1985; Brett and Waldron, 1996; Monties and Fukushima, 2001)

Zn

- A **cofactor** in enzymatic reactions,
- Is vital for many biochemical pathways of plants, including **photosynthesis** and sugar formation, protein synthesis, fertility and seed production, growth regulation
- and **defense against diseases**.

Experiment on Cu and Zn sources on Ganoderma infection of oil palm at main nursery stage

- Sources: Organic and inorganic
- Method of application: Soil and leaf spray
- 1 months old oil palm seedlings
- Treated for 4 months, then challenged with Ganoderma and allowed to grow for another 6 months
- Soil used is Munchong series (Typic Hapludox)

1-month old seedlings used

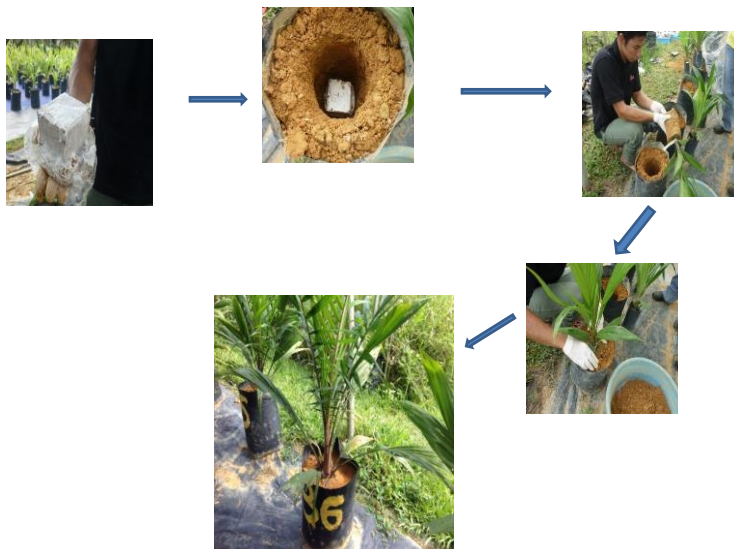


TREATMENTS

- ZnSO_4 Soil
- ZnSO_4 Foliar
- ZnEDTA Soil
- ZnEDTA Foliar
- CuSO_4 Soil
- CuSO_4 Foliar
- CuEDTA soil
- Cu EDTA Foliar
- $\text{CuSO}_4 + \text{ZnSO}_4$ soil
- $\text{CuSO}_4 + \text{ZnSO}_4$ Foliar
- $\text{CuEDTA} + \text{ZnEDTA}$ Soil
- $\text{CuEDTA} + \text{ZnEDTA}$ Foliar
- Control

13 treatments x 8 plants = 104 plants

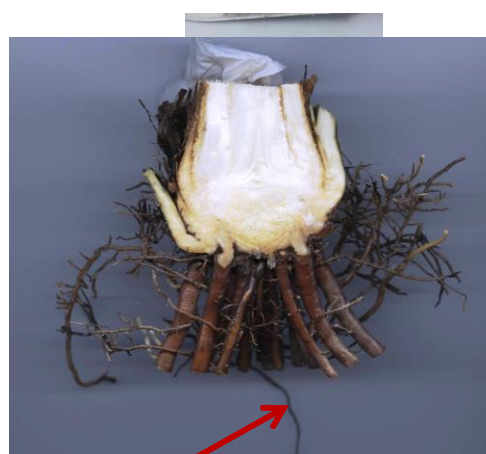
- Cu - 2 mg/plant
- Zn - 5 mg/plant



The control palms not challenged with Ganoderma, showing healthy root growth



Control + Ganoderma
(after 6 months)



Dead Roots

Soil applied CuEDTA



No infections were observed

CuSO_4 treated palm- soil applied



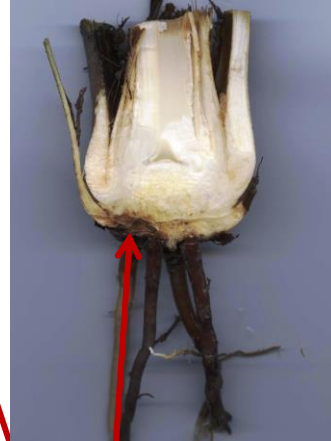
No infected area seen



ZnEDTA Soil applied



Infected root



Infection seen at the bole

ZnSO₄ treatment – soil applied



infection seen

$\text{CuSO}_4 + \text{ZnSO}_4$ soil treated



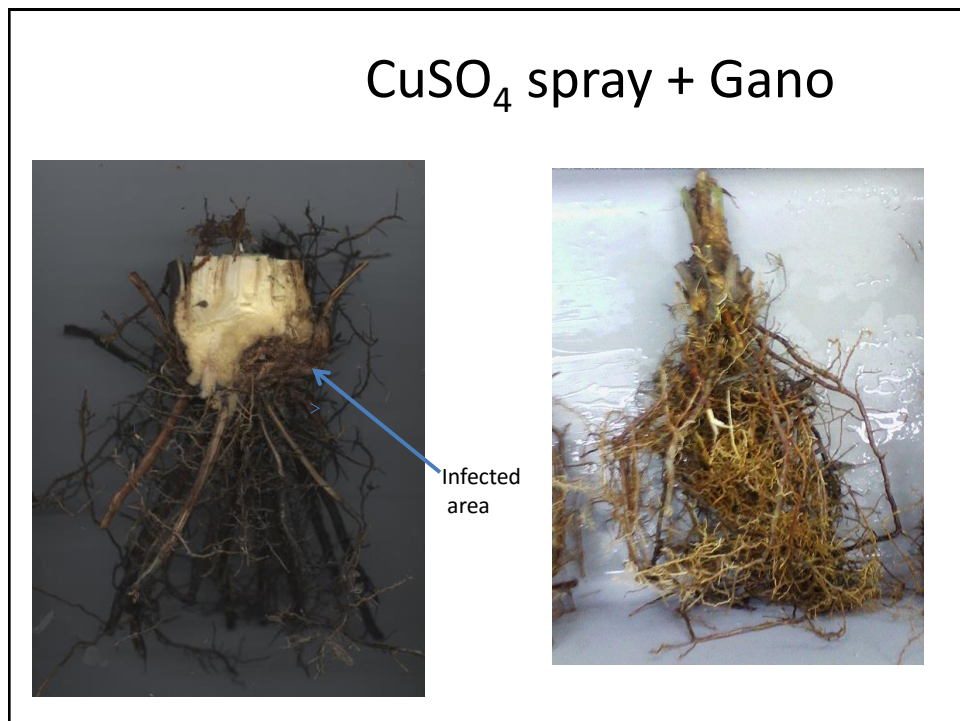
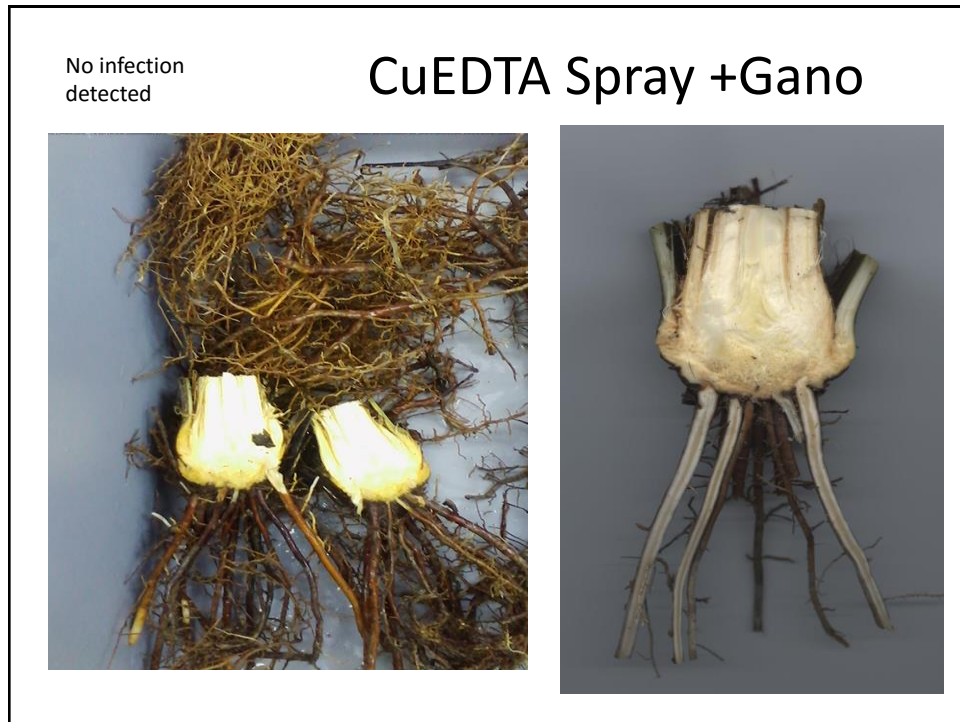
Some roots are infected



$\text{CuEDTA} + \text{Zn EDTA}$ soil applied



No infection observed



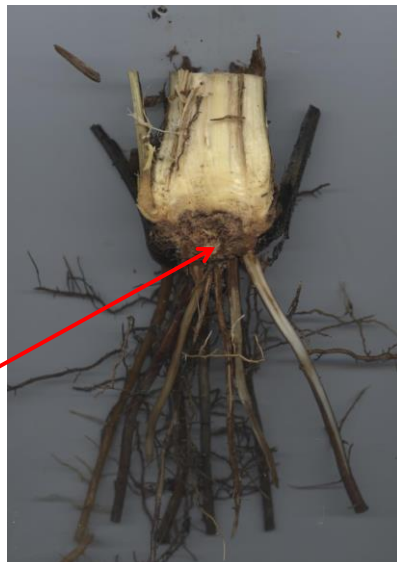
ZnSO₄ spray + Gano



Infected bole



ZnEDTA Spray + Gano



CuEDTA+ZnEDTA Foliar spray



Nutrien contents of palms after 6 months of **soil & foliar** treatments

TRT	N (Soil)	N (Foliar)	Cu (Soil)	Cu (Foliar)	Zn (Soil)	Zn (Foliar)
	%	%	mg/kg			
Control	2.10	2.10	16.5	16.5	138.6	138.6
Cu SO ₄	2.17	2.38	14.3	17.6	106.7	104.5
Zn SO ₄	1.68	2.17	12.10	6.60	111.1	130.9
Cu SO ₄ + Zn SO ₄	1.96	2.38	5.50	13.6	102.3	171.6
Cu EDTA	2.17	1.96	11.0	9.90	127.6	116.6
Zn EDTA	2.03	1.75	5.50	12.10	106.7	146.3
CuEDTA + ZnEDTA	1.75	1.96	11.1	13.2	105.6	118.8

Acid detergent lignin (%)

TREATMENT	% ADL
Zn SO ₄ (spray)	28.6
ZnEDTA (spray)	23.1
ZnSO ₄ + CuSO ₄	27.2
ZnEDTA + CuEDTA	26.9
CuEDTA	29.0
ZnSO ₄	26.8
CuSO ₄ (spray)	29.3
CuSO ₄	27.6
CuEDTA (spray)	59.7
ZnEDTA +CuEDTA (spray)	30.3
ZnEDTA	35.7
CONTROL	24.4

Conclusion

- Foliar spray is NOT effective in the plant's defense against Ganoderma infection
- Cu showed better response than Zn

Field Experiment

- Oil palm planted in September 2011.
- Treatments were made in December 2013, June 2014, December 2014 and June 2015
- Harvesting starts on 12th January 2015

Estimated Yield (kg/ha)

Treatments	Avg Yield per Palm (kg)	Avg Yield per ha per Year (kg)	Increase Compared to Control
Control	16.40	5009.5	-
CuSO ₄	16.05	4901.6	1.0
CuEDTA	34.21	10450.2	2.1
ZnSO ₄	29.43	8990.4	1.8
ZnEDTA	20.03	6119.2	1.2
ZnSO ₄ +CuSO ₄	17.25	5269.7	1.1
ZnEDTA+CuEDTA	33.02	10085.5	2.0

* Assume that one ha has 140 palms

** Average yield per palm is for 6 months.

32

THANK YOU