

Abstract No: A-467

IMPACT OF MINERAL NUTRITION MANAGEMENT ON *GANODERMA* INCIDENCE IN OIL PALM PLANTED ON PEAT SOIL

Pujiyanto, Achmad W.S, Dafian.P., Syaiful, Suhardi, Putri A.W and J.P Caliman

*SMART Research Institute, Indonesia***Corresponding author: pujiyanto_smartri@yahoo.com*

SUMMARY

The basal stem rot (BSR) disease of oil palm due to *Ganoderma* fungus is seriously threatening oil palm plantation in Malaysia and Indonesia, as well as part of Africa. Its increases with time and replanting cycles and therefore impact the profitability of the commodity. *Ganoderma* infection is widespread in mineral, peat, acid sulphate soils, etc. Mineral nutrition management on peat soil is undoubtedly an important factor to optimizing the nutrition balance of palms to producing high yield. However, it has been reported on many crops that mineral or organic fertilizers could affect the incidence of the diseases. Generally while some nutrients are favorable for the development of diseases, others seem to provide some protection to the plants. It is known that the equilibrium chemical composition in plants affect their resistance to pest and disease. Reports also mentioned that the change in soil mineral nutrition levels and balance due to fertilizer applications could also affect the soil microbial development, including pathogenic microbe. Here we report the results of a long-term field trial using NPK (3x3x3) fertilizer with 3 replicates was conducted during the period of 1999-2012 in a *Ganoderma* endemic area on peat soil in Riau-Indonesia. The objective of this study was to assess the impact of mineral fertilizer application on *Ganoderma* incidence on mature oil palm as well as on their productivity. The incidence of *Ganoderma* infection was observed regularly in the field by counting the number of dead palms in the treatment plots. The results indicated that the application of Phosphorus (P) and Nitrogen (N) fertilizers increased significantly the percentage of *Ganoderma* incidence; while the application of Potassium (K) fertilizer did not give a significant effect. Based on cumulative 14 years (1999 – 2012) observation the control (without P), the application of 0.45 kg P₂O₅/palm/year and 0.90 kg P₂O₅/palm/year increased the percentage of *Ganoderma* incidence 190 % and 240 % respectively. For N fertilizer treatments, the application of 0.69 kg N/palm/year and 1.38 kg N/palm/year increased the percentage of *Ganoderma* incidence by 16 % and 18 % respectively compare to control (without N). The estimated yield loss due to *Ganoderma* incidence recorded during observation (cumulative 1999-2012) on P treatments varied from 6 to 15 ton/ha (0.5 to 1.1 ton/ha/year) and for N treatments varied from 9 to 12 ton/ha (0.7 to 0.9 ton/ha/year) respectively.

Keywords: *Ganoderma*, peat, mineral nutrition management

INTRODUCTION

The basal stem rot (BSR) disease of oil palm due to *Ganoderma* fungus is seriously threatening oil palm plantation in Malaysia and Indonesia, as well as part of Africa with significant yield losses through direct loss of stand, reduce yield of infected palms. Generally, BSR increases with time and replanting cycles impacting the profitability of the commodity. *Ganoderma* infection is widespread in mineral, peat, acid sulphate soils, etc (Idris A S *et al.*, 2001).

Mineral nutrition management on peat soil is undoubtedly an important factor for optimizing the nutrition balance of palms to produce high yield. It has been reported in many crops that mineral or organic fertilizers could affect the incidence of diseases. Generally there are nutrients are favorable for the development of diseases, while others seem to provide some protection to the plants. Mohd Tayeb D. *et al.* (2003) reported highest incidence of *Ganoderma* occurred when the nitrogen and phosphorus levels were highest. The application of mineral fertilizers in different amount and form not only affect the growth and composition of the plant directly but also has profound effect on microbial activity in the soil and rhizosphere and plant tolerance to root pathogen (Marschner, 1995). Aciego *et al.* (2009) and Rousk *et al.* (2009) reported soil pH has marked effects on microbial biomass, community structure and response to substrate addition, where at low soil pH, fungal species were more dominant in the microbial community.

MATERIAL AND METHOD

The trial was conducted in the field from 1999 to 2011 on peat soil (Typic Tropohemist) in Riau-Indonesia. The planting material was DxP Socfindo planted in 1992 (density 143 palms/ha). The treatments used were: 1). Nitrogen (N), where N0 = 0 kg N/palm/year, N1 = 0.69 kg N/palm/year (1.5 kg Urea/palm/year) and N2 = 1.38 kg N/palm/yr (3.0 kg urea/palm/year). 2). Phosphorus (P), where P0 = 0 P₂O₅/palm/year, P1 = 0.45 kg P₂O₅/palm/year (1.5 kg Rock Phosphate/palm/year) and P2 = 0.90 kg P₂O₅/palm/year (3.0 kg Rock Phosphate/palm/year) and Potassium (K), K0 = 0 kg K₂O/palm/year, K1 = 1.5 kg K₂O/palm/year (2.5 kg MOP/palm/year) and K2=3.0 kg K₂O/palm/year (5.0 kg MOP/palm/year). An incompletely confounded factorial design with 3 replicates was employed. Homogenous fertilizers (CuSO₄, ZnSO₄ and HGFB) were applied yearly according to the dosage recommended based on foliar analysis. The incidence of *Ganoderma* infection was observed regularly in the field by counting the number of dead palms in the treatment plots. The census for *Ganoderma* incidence was conducted for all palms in every plot (49 palms/plot).

RESULTS AND DISCUSSION

Mineral Nutrition and *Ganoderma* Incidence

The result showed that, in general, the application of P fertilizer gave significant increasing number of dead palms due to *Ganoderma* attack (p-value < 0.01). During the observation period (1999-2012), the cumulative number of dead palms due to *Ganoderma* infection observed on P0, P1 and P2 was 30 %, 53 % and 73 %, respectively. Compared to control (without P application), the application of 0.45 kg P₂O₅/palm/yr (P1) and 0.90 kg P₂O₅/palm/yr (P2) increased the incidence of *Ganoderma* infection 190 % and 240 % respectively. The field observation also indicated that the appearance *Ganoderma* disease incidence was firstly reported in P2 (approximately 2 years after application), then in P1 (approximately 4 years after application) and P0 (approximately 5 years after application) (Figure 1A). This situation was paralleled with the rise of leaf P content (Figure 3-A).

N fertilizer gave significant effect on *Ganoderma* incidence (p-value < 0.01). An increased dosage of N fertilizer applied increased *Ganoderma* infection on oil palm in this soil. Statistically, the incidence of *Ganoderma* infection found in control (without N application) was significantly lower than that observed in N1 and N2 treatments. N1 and N2 treatments were not significantly different. Compared to the control, the N rates of N1 and N2 increased *Ganoderma* incidence by 16% and 18%, respectively (Figure 1B). The application of N fertilizer increased the leaf N content that may have contributed to the increase in *Ganoderma* infection (Figure 3B).

The application of potassium fertilizer did not give any significant effect on the incidence of *Ganoderma* infection in peat soil (p-value > 0.05). Figure 2A indicated that the incidence of *Ganoderma* infection was observed 4 years after application. 20 years after planting, the number of dead palms due to *Ganoderma* infection was about 54 % in control (K0) compared to 51 % in K1 and 55 % in K2, and the differences was not significant statistically. There was an interaction was a tendency to indicate N and K application on *Ganoderma* incidence (Figure 2B).

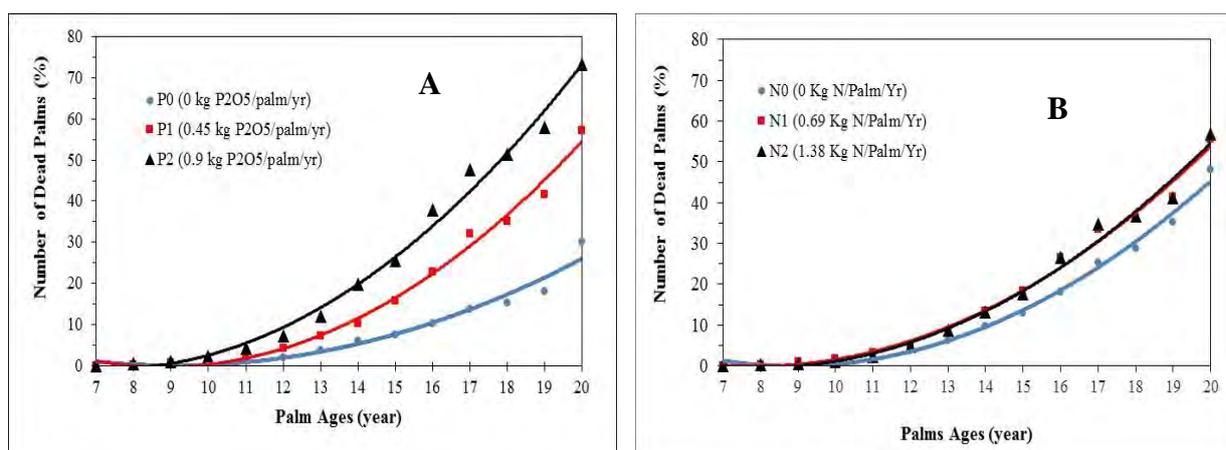


Figure 1: Impact of Phosphorus (A) and Nitrogen (B) application on Number of Dead Palm Due to *Ganoderma* infection in Peat Soil

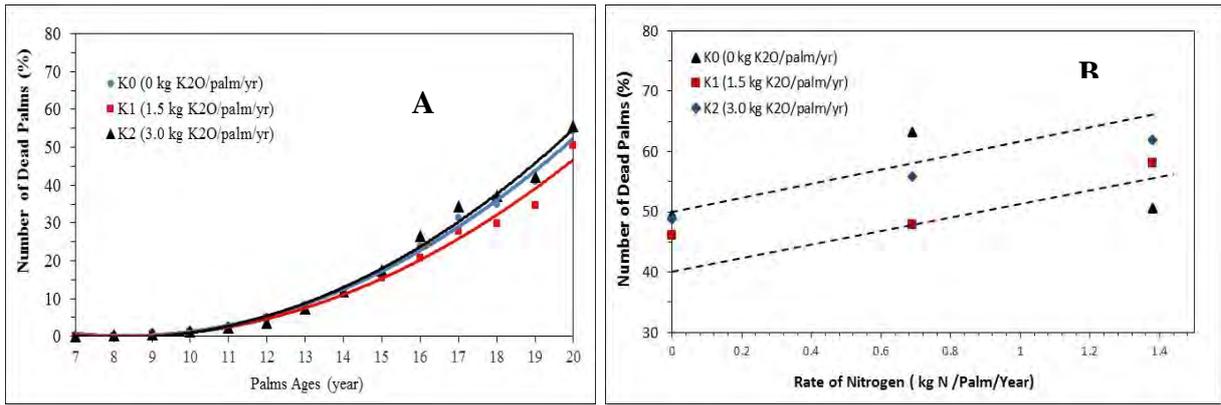


Figure 2: Impact of K Application (A) and N-K Interaction on Number of Dead Palm Due to *Ganoderma* infection in Peat Soil

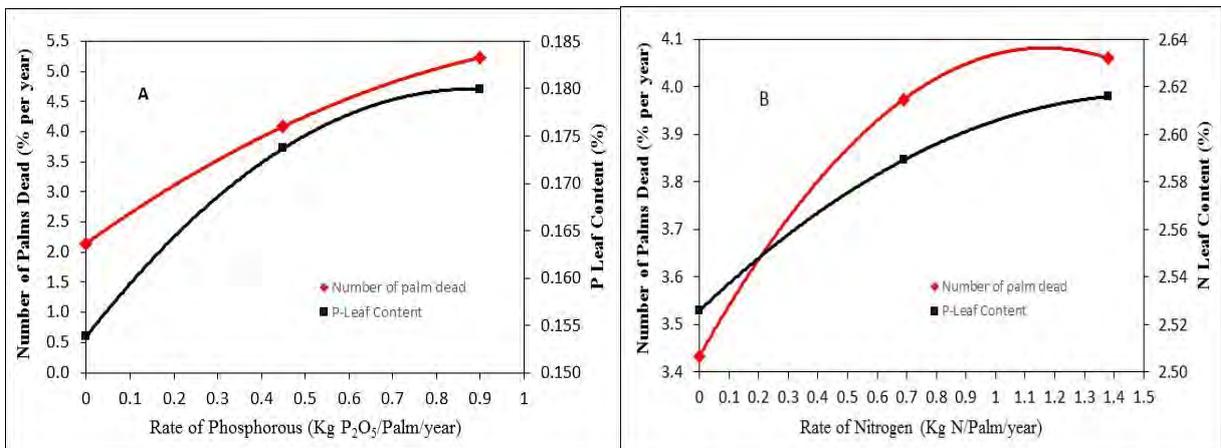


Figure 3: Correlation between The Rate of Phosphorus (A) and Nitrogen (B) With Incidence of *Ganoderma* infection and Leaf Nutrient.

Ganoderma and Oil Palm Yield

The average yield obtained during period 1999 - 2011 with different rates of N, P and K fertilizers can be seen in Table 1. The effect of application of these fertilizers was only significant on bunch weight, while on bunch number and average bunch weight, the effect was not significant statistically.

Table 1: Average Palm Yield Obtained by Different Rate N, P and K Fertilizers during Period 1999 – 2011.

| Parameters | Treatments | | | | | | | | | | | |
|---------------------------------|------------|------|------|-------|------------|------|------|-------|-----------|------|------|-------|
| | Nitrogen | | | | Phosphorus | | | | Potassium | | | |
| | N0 | N1 | N2 | Anova | P0 | P1 | P2 | Anova | K0 | K1 | K2 | Anova |
| Bunch Weight (ton/ha/yr) * | 19 | 22 | 21 | Sig | 21 | 22 | 19 | Sig | 19 | 21 | 21 | Sig |
| Bunch Number (Bunch/ha/yr)* | 1317 | 1398 | 1364 | NS | 1364 | 1407 | 1307 | NS | 1269 | 1417 | 1391 | NS |
| Average Bunch Weight (Kg/Bunch) | 14.7 | 15.4 | 15.2 | NS | 15.1 | 15.3 | 14.8 | NS | 15.3 | 14.6 | 15.1 | NS |

Note : *) extrapolation based on yield per palm/year and palm density 143 palms/ha; Sig: significant (p-value < 0.01); NS : Not Significant (p-value >0.05).

The estimation of yield loss due to *Ganoderma* incidence on area applied with P and N fertilizers is given in Figures 4 A and B. Based on the number of dead palm observed, the cumulative yield loss (during 14 years) in control (P0) was approximately 6 tons/ha (0.5 ton/ha/yr); while in P1 and P2, the cumulative yield loss estimated was approximately 12 tons/ha (0.9 ton/ha/yr) and 15 tons/ha (1.1 ton/ha/yr) respectively (Figure 4 A). For N application, the cumulative yield loss in control (N0) was approximately 9 tons/ha (0.7 ton/ha/yr) compared to 12 tons/ha (0.9 ton/ha/yr) in N1 and 12 tons/ha (0.9 ton/ha/yr) in N2 treatments. We also observed that the average cumulative yield loss due to *Ganoderma* incidence in K application was approximately 11 tons/ha (0.8 ton/ha/yr).

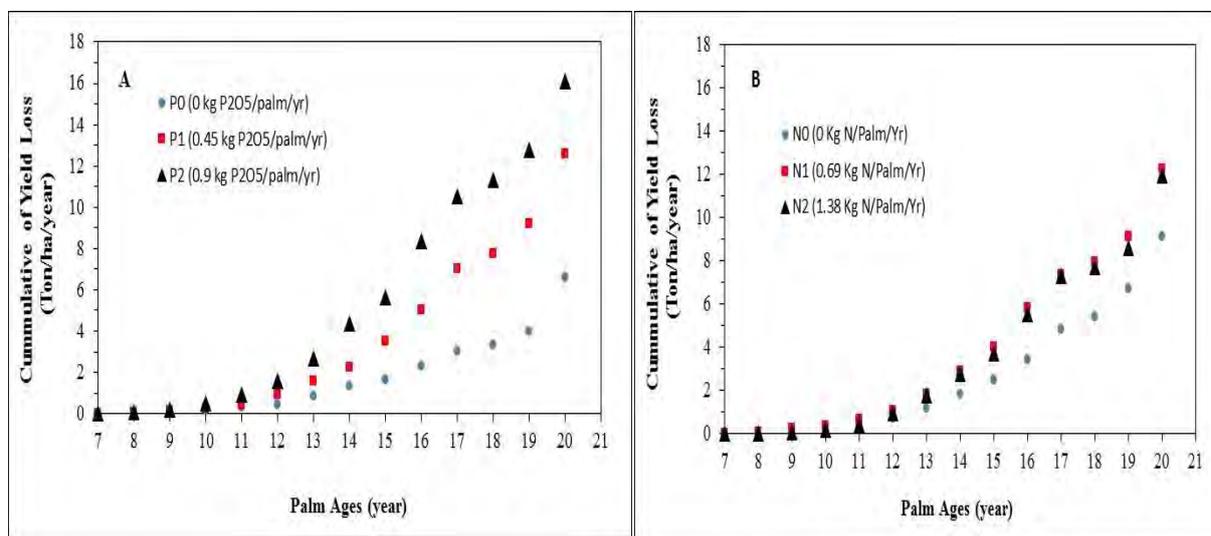


Figure 4: Loss Yield Estimated Due to *Ganoderma* Incidence on Different Rate of Phosphorus (A) and Nitrogen (B) Fertilizers

CONCLUSION

The application of Phosphorus (P) and Nitrogen (N) fertilizers increased significantly the percentage of *Ganoderma* incidence; while the application of Potassium (K) fertilizer was not significant. Based on the cumulative 14 years (1999 – 2012) observation, the application of 0.45 kg P₂O₅/palm/year and 0.90 kg P₂O₅/palm/year increased the percentage of *Ganoderma* incidence 190 % and 240 % respectively compared to the control (without P). For N fertilizer treatments, the application of 0.69 kg N/palm/year and 1.38 kg N/palm/year increased the percentage of *Ganoderma* incidence by 16 % and 18 % respectively compared to control (without N). The estimated yield loss due to *Ganoderma* incidence with P treatments varied from 6 to 15 ton/ha (0.5 to 1.1 ton/ha/year), for N treatments varied from 9 to 12 ton/ha (0.7 to 0.9 ton/ha/year) and for K 11 ton (0.8 ton/ha/year) respectively. Further study is required to explain the role of mineral fertilizer and its effect on reduce *Ganoderma* incidence or tolerance in oil palm.

ACKNOWLEDGEMENTS

The authors wish to thank the President Director of PT.Smart.Tbk for permission to publish this paper. The cooperation by FOES Dept. and supporting staff of the Agronomy Dept. of SMARTRI are gratefully acknowledged.

REFERENCES

1. Aciego Pietri JC, Brookes PC (2009) Substrate input and pH as factors controlling microbial biomass, activity and community structure in an arable soil. *Soil Biol Biochem* 41:1396.
2. Idris AS, Arrifin D, Watt TA and Swinburne TR (2001) Distribution of species of *Ganoderma* Basal Stem Rot of Oil Palm in Relation to the Environmental Condition in Peninsular Malaysia, In Proc. International Palm Oil Congress., Kuala Lumpur., 20 – 22 august 2001., MPOB .p.385-394.
3. Marschner, H (1995) Mineral Nutrition of Higher Plants, second edition. Academic Press Limited London.,p437.
4. Mohd Tayeb, D, Idris Abu Seman and Mohd Haniff Harun (2003), Reduction of *Ganoderma* Infection in Oil Palm Through Blanced Fertilization in Peat, In Proc. International Palm Oil Congress., Putrajaya Malaysia., 24 – 28 august 2003., MPOB .p.193-218.
5. Rousk J, Brookes PC, Baat E (2009) Constrating Soil pH effect on fungal and bacterial growth suggest functional redundancy in carbon mineralization. *Appl. Environ. Microbial* 75:1589-1596.