

**EFFECTS OF ALACHLOR AND GLYPHOSATE ON
DEVELOPMENT OF *Glomus mosseae* AND ITS SYMBIOTIC
ASSOCIATION WITH PEANUT**

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**DOCTOR OF PHILOSOPHY
UNIVERSITI PUTRA MALAYSIA**

2004

Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

**EFFECTS OF ALACHLOR AND GLYPHOSATE ON DEVELOPMENT OF
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By

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August 2004

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Data on the effect of herbicides on vesicular-arbuscular mycorrhiza (VAM) symbiosis is still lacking as compared to fungicides. This study aims to evaluate the effect of alachlor (soil acting herbicide) and glyphosate (foliage acting herbicides) on *Glomus mosseae* (VAM fungus) growth phases directly and indirectly on its symbiotic association with peanut plant. Laboratory experiment was carried out to determine the effects of herbicides on spore germination and hyphal growth of *G. mosseae*. The recommended rates of alachlor for soil and water agar media are $3.6 \mu\text{g ai g}^{-1}$ soil and $24 \mu\text{g ai mL}^{-1}$ agar, and for glyphosate are $2.16 \mu\text{g ae g}^{-1}$ soil and $14 \mu\text{g ae mL}^{-1}$ agar, respectively. Alachlor at ten fold of the recommended rate significantly ($P \leq 0.01$) reduced spore germination of *G. mosseae* by 36 and 43%, and hyphal length was reduced by 61 and 83% in soil and water agar media, respectively. The application of alachlor at ten folds of the recommended rate ($36 \mu\text{g ai g}^{-1}$) reduced the length of active external hyphae of *G. mosseae* by 40% (23.99 cm g^{-1}). Alachlor at one and half of the recommended rate ($5.4 \mu\text{g ai g}^{-1}$) decreased the development and succinate dehydrogenase (SDH) activity

of internal hyphae of *G. mosseae*, and amount of mycorrhizal tissue. In contrast, glyphosate at all rates had no negative effects on spore germination and hyphal length of *G. mosseae* in both soil and water agar media, and also did not affect the external and internal hyphae.

The effect of herbicides on *G. mosseae* symbiosis with peanut was also studied in the greenhouse. The adverse effects of alachlor on the mycorrhizal plants was greater than in non-mycorrhizal plants. The phosphorus concentration in the shoot was unaffected by alachlor in the non-mycorrhizal plant or by glyphosate in the mycorrhizal plant and vice versa. Alachlor and glyphosate did not affect P inflow into non-mycorrhizal plants. However, P inflow into mycorrhizal plant was increased by glyphosate application at $2.16 \mu\text{g ae g}^{-1}$ which gave $65.31 \times 10^{-13} \text{ mol P m}^{-1} \text{ s}^{-1}$. It increased hyphal inflow of $41.48 \times 10^{-13} \text{ mol P m}^{-1} \text{ s}^{-1}$, and consequently increased hyphal uptake from soil to be 479.72 from $48.04 \times 10^{-13} \text{ mol P m}^{-1} \text{ s}^{-1}$ in control. The effect of *G. mosseae* on the persistence and degradation of herbicides in the soil showed that the rate of degradation of alachlor was higher in *G. mosseae* inoculated soil than in the uninoculated soil. Therefore, the persistence of alachlor in the soil was shortened by 6 days with the presence of *G. mosseae*. However, the persistence of glyphosate in the soil was unaffected by the presence of the fungi.

The result of study showed that the type of herbicides and their rates are important factors mediating the effects of herbicides on *G. mosseae* and its symbiosis with peanut plant. The distinct growth phases of *G. mosseae* may differ in their tolerance to alachlor

herbicide. There was an interaction between alachlor and *G. mosseae* which was indicated by the adverse effect on mycorrhizal plants, and evidence that the persistence of alachlor in the soil was shortened by the fungi. In contrast, glyphosate did not affect the growth phases of *G. mosseae*.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGARUH ALAKLOR DAN GLIFOSAT KE ATAS PERKEMBANGAN *G. mosseae* DAN HUBUNGAN SIMBIOTIKNYA DENGAN KACANG TANAH

Oleh

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Data mengenai pengaruh racun herba keatas simbiosis “vesicular-arbuscular mycorrhiza (VAM)” ini masih jarang dibandingkan pada racun kulat. Kajian ini bertujuan untuk menilai pengaruh alaklor (racun herba yang bertindak melalui tanah) dan glifosat (racun herba yang bertindak melalui daun) ke atas fasa-fasa pertumbuhan *Glomus mosseae* (kulat “VAM”) secara langsung, dan secara tidak langsung ke atas hubungan simbiotiknya dengan kacang tanah. Percubaan di makmal dijalankan untuk menentukan kesan racun herba ke atas percambahan spora and pertumbuhan hifa *G. mosseae*. Kadar-kadar alaklor yang disyorkan untuk media tanah dan “water agar” adalah $3.6 \mu\text{g ai g}^{-1}$ tanah and $24 \mu\text{g ai mL}^{-1}$ agar, dan untuk glifosat adalah $2.16 \mu\text{g ae g}^{-1}$ tanah and $14 \mu\text{g ae mL}^{-1}$ agar, berturut-turut. Alaklor pada sepuluh kali ganda kadar yang disyorkan nyata sekali ($P \leq 0.01$) mengurangkan percambahan spora *G. mosseae* 36 dan 43% dan pemanjangan hifa dikurangkan 61 dan 83% dalam masing-masing media tanah dan “water agar”. Aplikasi alaklor pada sepuluh kali ganda kadar yang disyorkan ($36 \mu\text{g ai g}^{-1}$) mengurangkan panjang hifa aktif 40% (23.99 cm g^{-1}). Alaklor pada kadar satu

setengah kali dari kadar yang disyorkan ($5.4 \mu\text{g ai g}^{-1}$) mengurangi perkembangan dan aktiviti “succinate dehydrogenase” (SDH) hifa internal *G. mosseae*, dan jumlah tisu mikorizal. Sebaliknya glifosat pada seluruh kadar tidak memberi kesan negatif ke atas percambahan spora dan pemanjangan hifa *G. mosseae* dalam kedua-dua media tanah dan “water agar”, dan tidak mempengaruhi hifa eksternal dan internal.

Pengaruh racun herba ke atas simbiosis *G. mosseae* dengan kacang tanah juga telah dikaji di rumah kaca. Kesan negatif alaklor ke atas tanaman yang diinokulasi dengan mikoriza adalah lebih besar berbanding tanaman yang tidak diinokulasi dengan mikoriza. Konsentrasi fosforus pada pucuk tidak dipengaruhi oleh alaklor pada tanaman tanpa mikoriza, atau oleh glifosat pada tanaman yang mengandungi mikoriza dan sebaliknya. Alaklor dan glifosat tidak mempengaruhi aliran fosforus pada tanaman tanpa mikoriza. Tetapi aliran fosforus kepada tanaman yang mempunyai mikoriza ditingkatkan oleh penggunaan glifosat pada kadar $2.16 \mu\text{g ae g}^{-1}$ yang memberikan $65.31 \times 10^{-13} \text{ mol P m}^{-1} \text{ s}^{-1}$. Ini meningkatkan aliran hifa $41.48 \times 10^{-13} \text{ mol P m}^{-1} \text{ s}^{-1}$, dan selanjutnya meningkatkan pengambilan fosforus melalui hifa dari tanah kepada 479.72 dibandingkan $48.04 \times 10^{-13} \text{ mol P m}^{-1} \text{ s}^{-1}$ pada kontrol. Pengaruh *G. mosseae* ke atas persistensi dan degradasi racun herba dalam tanah menunjukkan kadar degradasi alaklor adalah lebih tinggi pada tanah yang diinokulasi dengan *G. mosseae* berbanding dengan tanah yang tidak diinokulasi. Oleh itu, persistensi alaklor dipendekkan 6 hari dengan kehadiran *G. mosseae*. Akan tetapi, persistensi glifosat tidak dipengaruhi dengan kehadiran kulat ini.

Hasil kajian menunjukkan bahawa jenis racun herba dan kadarnya adalah faktor penting pengantara kesan racun herba ke atas *G. mosseae* dan simbiosisnya dengan kacang tanah. Fasa-fasa pertumbuhan *G. mosseae* yang berbeza juga boleh membezakan toleransi mereka ke atas racun herba alaklor. Terdapat interaksi antara alaklor dan *G. mosseae* yang ditunjukkan melalui kesan negatif ke atas tanaman yang mempunyai mikoriza, dan bukti bahawa persistensi alaklor dipendekkan dengan kehadiran kulat tersebut dalam tanah. Sebaliknya, glifosat tidak mempengaruhi seluruh fasa pertumbuhan *G. mosseae*.

ACKNOWLEDGEMENTS

In the name of Allah the Beneficent and the Compassionate. Praise to almighty Allah SWT for his blessings who enabled me to complete this thesis and achieve the highest academic degree.

I wish to express my deepest gratitude and sincere appreciation to Professor Dr. Rosli Mohamad, the chairman of the supervisory committee for his guidance, constant encouragement, invaluable suggestions and generous help throughout the study period and in preparing this manuscript.

My sincere appreciation also goes to the members of my supervisory committee, Prof. Dr. Azizah Hashim, Prof. Dr. Zaharah Abd. Rahman, and Prof. Dr. Dzolkhifli Omar for their advice and constructive suggestions and correcting this manuscript. Special thanks are also extended to Dr. Anuar Abd. Rahim for his help in the statistical analysis. My sincere thanks are also due to Mr. Teng Yeew Thai, Monsanto (M) Sdn Bhd. for providing technical herbicides used.

I appreciate the help and cooperation of my laboratory colleagues, Dr. Imran Khan, Dr. Maria Viva Rini, Mr. Yahya Bazlan, and Mr. Ismail Yusa. I also acknowledge the help of technical staff of the Faculty of Agriculture, UPM, especially Mr. Jarkasi, Mr. Manan, Mr. Hishamuddin, Mr. Talib, Mr. Nazri, Mrs. Fauziah, Mr. Mahyudin Othman, Mr. Junaidi.

I am thankful to all of my friends and colleagues, especially Mr. Prama Yufdi, Mr. Iing Lukman, Dr. Adrinal Tata, Dr. Muhrizal Syarwani, Mr. Kayamuddin Panjaitan for their help and moral encouragement.

To my family, particularly my mother and father, brothers and sister. I am grateful to my beloved wife, Masyitah and my beloved children for their immense help, encouragement, inspiration, patience, unfailing support and sacrifice.

I acknowledge the Universiti Putra Malaysia for giving me scholarship in GSS scheme to fund and support my study. SEAMEO-SEARCA was also appreciated for awarding me the SEARCA-thesis Grant which partly helps to fund the thesis. Last but not least I am grateful to Islamic University of North Sumatra for the support and help in my study.

I certify that an Examination Committee met on 16th August 2004 to conduct the final examination of Askif Pasaribu on his Doctor of Philosophy thesis entitled “Effects of Alachlor and Glyphosate on Development of *Glomus mosseae* and its Symbiotic Association with Peanut” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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