UNIVERSITI PUTRA MALAYSIA

EVALUATION OF PALM OIL BASED OLEOCHEMICALS AS HERBICIDE SURFACTANT

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Thesis Submitted in Fulfilment of the Requirements for the
Degree of Master of Agricultural Science in the
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Dedicated To:

To my beloved mother, sisters, brothers and friends

Whose true love, support and inspiration made this work possible

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Agricultural Science.

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Chairman : Associate Professor Dzolkhifli Omar, Ph.D.

Faculty : Agriculture

The effect of adding oleochemical-based surfactants (Agrimul PG2069, Agrimul PG2067, S1 and methyl oleate) in comparison with the organosilicone surfactant (Silwet L-77) on properties of spray solution, efficacy and uptake of glyphosate (Roundup®) for the control of *P. conjugatum* and *D. ocimifolia* was evaluated in the greenhouse. The dose-response study of glyphosate on 4-5 week old *P. conjugatum* and *D. ocimifolia* was first established. Glyphosate at 1.0 kg a.e/ha and above gave >90% mortality of the plants at 10 and 14 days after treatment (DAT) for *P. conjugatum* and *D. ocimifolia*, respectively. The spray deposition study showed higher amount of fluorescein deposited at these concentrations. It was estimated that glyphosate at 0.46 kg a.e/ha and 1.0 kg a.e/ha gave 50% mortality of *P. conjugatum* and *D. ocimifolia*, respectively and these rates were used in subsequent studies.

Adding Agrimul PG2069 (0.025 ml/litre) and Agrimul PG2069 (0.05 ml/litre) to glyphosate spray solution gave significantly better control of *P. conjugatum* compared with other treatments at 10 DAT. However, methyl oleate (0.1 ml/litre) and Silwet L-77 (0.5 ml/litre) showed the highest spray deposition. On *D. ocimifolia*, methyl oleate at all 3 concentrations tested (0.025, 0.05 and 0.1 ml/litre) together with Silwet L-77 (0.25 ml/litre) showed significantly better efficacy compared to others at 14 DAT. The spray deposition of these surfactants was also observed to be the highest.

When the reduction of surface tension of the glyphosate spray solution as affected by the types and concentrations of surfactant was determined, the critical micelle concentration (CMC) for Agrimul PG2069, Agrimul PG2067 and S1 was at 0.5 ml/litre while Silwet L-77 was between 0.1-0.5 ml/litre. The CMC of methyl oleate was at 0.05 ml/lire. The concentration of 0.05 ml/litre and 0.5 ml/litre of methyl oleate and Silwet L-77 respectively gave better spread of droplets on the upper leaf surfaces of *P. conjugatum*. On *D. ocimifolia*, the Silwet L-77 spread better than methyl oleate. The wax on the leaf of *P. ocnjugatum* was found to be 4 time higher than *D. ocimifolia*. This could affect the spray deposition and spread of the droplets on the leaf surfaces.

The influence of the surfactants on uptake of glyphosate by *P. conjugatum* and *D. ocimifolia* was also evaluated using radiolabelled C-14. The uptake of

glyphosate by *P. conjugatum* was significantly higher when methyl oleate (0.05 ml/litre) and Silwet L-77 (0.5 ml/litre) were added but this result was not observed on *D. ocimifolia*. No significant different was also observed when the uptake from methyl oleate was compared with Silwet L-77 for both species.

Abstrak tesis ini dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains Pertanian.

PENILAIAN KIMIA OLEO MINYAK KELAPA SAWIT SEBAGAI SURFAKTAN UNTUK RACUN RUMPAI

Oleh

ZAHARIMAN MOHD. SHAH

April 2000

Pengerusi : Profesor Madya Dzolkhifli Omar, Ph.D.

Fakulti : Pertanian

Kesan penambahan surfaktan berasaskan kimia oleo (Agrimul PG2067, Agrimul PG2069, S1 dan oleat metil) berkaitan dengan keberkesanan larutan semburan dan proses pengambilan masuk glyphosate (Roundup®) ke dalam tumbuhan untuk pengawalan *P. conjugatum* dan *D. ocimifolia* telah di lakukan di rumah hijau untuk membandingkan dengan kesan penambahan surfaktan organosilikon. Kajian dos-respon glifosat terhadap *P. conjugatum* dan *D. ocimifolia* yang berumur 4-5 minggu telah dilakukan terlebih dahulu. Didapati penggunaan glifosat dengan kadar melebihi 1.0 kg a.e/ha telah memberi peratus kematian melebihi 90% pada hari ke-10 untuk *P. conjugatum* dan *D. ocimifolia* pada hari ke-14. Kajian penahanan semburan telah menunjukan jumlah penahanan fluorescein yang tinggi berlaku di kepekatan tersebut. Penggunaan glifosat pada kadar 0.46 kg

a.e/ha dan 1.0 kg a.e/ha yang menunjukkan 50% kematian untuk *P. conjugatum* dan *D. ocimifolia* telah digunakan untuk kajian seterusnya.

Kesan penambahan Agrimul PG2069 (0.025 ml/liter) dan Agrimul PG2067 (0.05 ml/liter) ke dalam larutan glifosat telah memberikan pengawalan yang baik untuk *P. conjugatum* berbanding dengan rawatan yang lain pada hari ke-10. Walaupun begitu, untuk kajian penahanan semburan, penggunaan oleat metil (0.1 ml/liter) dan Silwet L-77 (0.5 ml/liter) menunjukkan penahanan semburan yang tertinggi. Pada hari ke-14, ujian menggunakan ketiga-tiga kepekatan oleat metil (0.025, 0.05 dan 0.1 ml/liter) bersama dengan Silwet L-77 (0.25 ml/liter) ke atas *D. ocimifolia* telah menunjukkan pengawalan yang sangat berkesan berbanding dengan rawatan yang lain. Kajian penahanan semburan untuk surfaktan ini pada tahap kepekatan yang sama juga telah menunjukkan keputusan yang tertinggi.

Penentuan pengurangan ketegangan permukaan larutan glifosat yang dipengaruhi oleh kepekatan surfaktan menunjukkan CMC (Critical Micelle Concentration) untuk Agrimul PG2069, Agrimul PG2067 dan S1 didapati pada kepekatan 0.5 ml/liter manakala Silwet L-77 adalah di antara 0.1-0.5 ml/liter. Keputusan CMC untuk oleat metil adalah pada kepekatan 0.05 ml/liter. Kepekatan oleat metil pada 0.05 ml/liter dan Silwet L-77 pada 0.5 ml/liter memberi penyerakan titisan semburan yang baik di bahagian atas daun *P. conjugatum*. Untuk *D. ocimifolia*, Silwet L-77 memberi penyerakan yang baik berbanding dengan oleat metil. Jumlah lilin pada daun *P. conjugatum* telah ditemui melebihi 4 kali ganda

banyak berbanding dengan *D. ocimifolia*. Penemuan ini kemungkinan telah memberi kesan ke atas penahanan semburan dan penyerakan titisan semburan di atas daun-daun.

Pengaruh surfaktan ke atas pengambilan glifosat oleh *P. conjugatum* dan *D. ocimifolia* telah di nilai melalui kaedah radiolabbeled C-14. Pengambilan dan kemasukkan glifosat oleh *P. conjugatum* apabila ditambah oleat metil (0.05 ml/liter) dan Silwet L-77 (0.5 ml/liter) adalah tinggi, tetapi keputusan ini tidak ditemui apabila menggunakan *D. ocimifolia*. Tiada perbezaan yang bererti di dalam pengambilan glifosat di antara oleat metil dan Silwet L-77 untuk kedua jenis rumpai ini.

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LIST OF ABBREVIATIONS

m^2	= Square metre
%	= Percentage
cm	= Centimetre
kg	= Kilogram
a.i	= Active ingredient
a.e	= Active equivalent
L	= Litre
Ha	= Hectare
µm	= Micrometer
µg	= Microgram
m	= Metre
mg	= Milligram
mm/ou	= Millimetre/onucular unit
h	= Hour
µl	= Microlitre
°C	= Degree centigrade
w/v	= Weight per volume
v/v	= Volume per volume
w/w	= Weight over weight
DAT	= Days after treatment
DAS	= Day after sowing
WSSA	= Weed Science Society of America

CHAPTER 1

INTRODUCTION

Glyphosate is relatively non-selective and is particularly valuable for the control of most perennial weeds. It also controls most annual species of grasses, sedges, and broad leaf (Martin and Worthing, 1974). It is applied to the foliage of the vegetation to be controlled. It is essentially nonphytotoxic as a soil application (Klingman and Murray, 1976), readily absorbed by most species and highly mobile in the phloem and probably also in the xylem (Devine, 1993). The uptake of glyphosate in leaf surface is very rapid compared with penetration process and it has a longer phase between the uptake process and penetration. These phases are dependent on species, age, environmental condition and concentration of glyphosate and surfactants (Caseley and Coupland, 1985).

Surface active agents, or 'surfactant', have an impact on all aspects of our daily life, either directly in household detergents and personnel care products or indirectly in the production and processing of the materials which surround us (Karsa, 1987). In formulation of foliar-applied agrochemicals, surfactants are commonly used to improve physical/chemical properties of the spray solution and to enhance uptake of the active ingredient (Knoche and Bukovac, 1993). Surfactants may also increase the solubility of active ingredient in the spray solution, affect spray retention, droplet spreading and drying rates (Gaskin and Holloway, 1992).

The utilization of organosilicone-based surfactant in pesticide formulation improved the foliar uptake of glyphosate due to excellent wetting and penetrating characteristic when compared with conventional surfactants (Bishop and Field, 1983; Jansen, 1973). However, in recent years there has been a trend of using oils extracted from crop seeds such as soybean, sunflower, canola and coconut as surfactant. These crop seed oils and their derivatives known as oleochemicals could provide an economical, locally supplied, and renewable source of adjuvant (Matthews and Hislop, 1993). Oleochemical surfactants also have both economic and ecological advantages over the products based on mineral oil (Baumann and Biermann, 1994).

Oleochemicals are chemicals derived from natural oils and fats. The important base of oleochemicals, which are essentially the building blocks of the oleochemical industry, are fatty acids, methyl esters, fatty alcohols, and fatty amines. These oleochemicals, together with their derivatives, have large variety of end uses (Ong *et al.*, 1989). Alkyl alcohol ethoxylates derived from vegetable oils and their derivatives are the most important class of non-ionic surfactant used as wetting agent. At present, there is an interest to produce surfactants largely from natural starting materials such as carbohydrates (starch, sugar, *etc.*) for ecological reasons along with natural oil and fats (Baumann and Biermann, 1994).

The objective of this research was to study the effect of leaf surface on efficacy of glyphosate, effect of adding oleochemical-based surfactants on efficacy and

absorption of glyphosate by *P. conjugatum* and *D. ocimifolia.* The research consisted three parts. Part one was a preliminary screening on dose response effect of glyphosate and effect of surfactants (oleochemical-based surfactant and organosilicone surfactant) on the effectiveness of glyphosate for the control *P. conjugatum* and *D. ocimifolia.* The second part was to study the uptake of glyphosate with and without surfactants. Lastly, study was conducted to find the effect of surface tension, spread coefficient and wax weight on efficacy of spray formulation.

CHAPTER 2

LITERATURE REVIEW

2.1 Glyphosate

Glyphosate or N-(phosphonomethyl)glycine has been considered as one of the most important organophosphorus herbicides (Hance and Holly, 1990). It was first described by Baird *et al.*, in the year 1971, and initially marketed under the trade name Roundup® by Monsanto Co. U.S.A., in the isopropylamine salt formulation.

Glyphosate is a nonselective herbicide and is particularly valuable for the control of most perennial and annual weed species (Martin and Worthing, 1974). It is essentially nonphytotoxic as a soil application because it is tightly bound to most soils and unavailable to plants (Klingman and Murray, 1976). It is readily absorbed by most species and highly mobile in the phloem and probably also in the xylem (Devine, 1993).

The effectiveness of foliar applied glyphosate in controlling perennial weeds and killing underground buds as well as apical meristem strongly suggests that it is readily absorbed by leaves and translocated in the symplast. It could provide complete control of weeds both above and below ground with a single foliar application (Hance and Holly, 1990).