UNIVERSITI PUTRA MALAYSIA

EVALUATION OF MULCHING MATS DERIVED FROM RICE STRAW AND OIL PALM EMPTY FRUIT BUNCHES FOR WEED CONTROL

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BY

HALA ELTAHIR ALLOUB

Thesis Submitted in Fulfilment of the Requirements for the Degree in Master of Science in the Faculty of Agriculture University Putra Malaysia

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Dedicated to

To my beloved mother, father, sisters and brothers

Whose true love, support and inspiration

made this work possible

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LIST OF ABBREVIATIONS

^0C	Degree Celsius
C/N	Carbon to nitrogen
C4	C4 pathway of photosynthesis
dw	Dry weight
g	Gram
H	Metolachlor herbicide
H1	Metolachlor 1.8 kg/ha
H2	Metolachlor 3.6 kg/ha
kg/ha	Kilogram per hectare
m	Meter
OPEFB	Oil palm empty fruit bunches
pH	Hydrogen-ion-concentration
RS	Rice straw
RSM1	Rice straw mat 0.005 cm thickness
RSM2	Rice straw mat 0.01 cm thickness
RSM3	Rice straw mat 0.015 cm thickness
%	Percent

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

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June 1999

Chairman: Associate Professor Amartalingam Rajan Ph.D.

Faculty: Agriculture

Field experiments were conducted at Universiti Putra Malaysia during 1998 under annual and permanent orchard cropping systems to evaluate oil palm empty fruit bunch (OPEFB) and rice straw (RS) mats, with and without metolachlor as preemergence herbicide, for weed control efficacy, metolachlor activity and soil nutrient status.

Under the annual cropping system, three RS mat types (1.5, 1.0, and 0.5 cm thick) and one OPEFB mat type (1.5 cm thick), with and without incorporated metolachlor (1.8 kg/ha) were compared for annual weed control. In the permanent orchard system, two RS mat types (1.5 and 1.0, cm thick) and one OPEFB mat type (1.5 cm thick) with and without incorporated metolachlor (1.8 and 3.6 kg/ha) were compared for perennial weed control.

OPEFB mats effectively suppressed annual weed growth. Incorporation of 1.8 kg/ha metolachlor increased weed control efficacy. Increasing metolachlor to 3.6 kg/ha increased the efficacy of the mats for perennial weed control. However, incorporation of metolachlor 1.8 kg/ha into OPEFB mats had no beneficial effect in controlling perennial grass weed growth compared to mats without herbicide.

RS mats without herbicide did not effectively suppress growth of most weeds. Incorporation of 1.8 kg/ha metolachlor enhanced suppression of annual weed growth up to 12 weeks after treatment. At 3.6 kg/ha metolachlor effectively suppressed perennial weed growth up to 16 weeks after treatment.

Root length reduction in rice seedling bioassay was used to evaluate residual phytotoxic activity of field exposed metolachlor treated OPEFB and RS mats. At both metolachlor rates no inhibitory activity was evident in mats sampled after 8 weeks of exposure in the field.

OPEFB mats markedly increased soil organic matter (10.6%), organic carbon (10.6%), phosphorous (15.3%) and potassium (49.9%) with negligible increase in nitrogen (5.6%). Contribution by triple layered RS mats to soil organic matter (9.3%), organic carbon (9.3%) potassium (73.8%) and phosphorous (18.7%) was greater than contributions from single or double layered RS mats.

The results of this study showed that OPEFB mats incorporated with 3.6 kg/ha metolachlor have excellent potential for weed control around newly transplanted trees and shrubs. Triple layered RS mats in combination with 3.6 kg/ha metolachlor can also be used to effectively control weeds under young perennial crops.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi Keperluan untuk Ijazah Master Sains

PENILAIAN KEPINGAN SUNGKUPAN BUATAN JERAMI PADI DAN TANDAN KOSONG KELAPA SAWIT UNTUK PENGAWALAN RUMPAI

Oleh

HALA ELTAHIR ALLOUB

Jun 1999

Pengerusi: Profesor. Madya Amartalingam Rajan, Ph.D

Fakulti: Pertanian

Kajian dijalankan di Universiti Putra Malaysia pada tahun 1998 di ladang tanaman semusim dan tanaman saka untuk menilai kepingan sungkupan buatan tandan sawit kosong (OPEFB) dan jerami padi (RS) terhadap kawalan rumpai, dan pengaruh keatas aktiviti metolachlor dan status nutrien tanah.

Di ladang tanaman semusim tiga jenis sungkupan jerami padi (1.5, 1.0 dan 0.5 cm tebal) dan satu jenis sungkupan OPEFB (1.5 cm tebal) yang dicampurkan dengan metolachlor pada kadar 1.8 kg/ha dibandingkan dengan rawatan tanpa racun rumpai sebagai kawalan bagi pengalawan rumpai semusim (annual). Di dalam kajian berasingan di ladang tanaman saka pula, dua jenis sungkupan menggunakan jerami padi (1.5 dan 1.0 cm tebal) dan satu jenis sungkupan menggunakan OPEFB (1.5 cm tebal) yang dicampurkan dengan metolachlor pada kadar

1.8 dan 3.6 kg/ha dibandingkan dengan rawatan tanpa racun rumpai dijalankan bagi pengawalan rumpai saka (perennial).

Hasil kajian menunjukkan rawatan menggunakan sungkupan OPEFB dapat menghalang tumbesaran rumpai semusim dengan berkesan. Tumbesaran rumpai ini dapat dihalang dengan lebih berkesan lagi apabila sungkupuan OPEFB dicampurkan dengan 1.8 kg/ha metolachlor. Peningkatan kadar metolachlor kepada 3.6 kg/ha yang dicampur kepada sungkupan OPEFB dapat meningkatkan keberkesanan pengawalan rumpai saka. Walau bagaimanapun, sungkupan OPEFB yang dicampur dengan 1.8 kg/ha metolachlor tidak berbeza bagi mengawal tumbesaran rumpai saka berbanding OPEFB tanpa racun rumpai.

Sungkupan RS tanpa racun tidak berkesan untuk mengawal tumbesaran semua rumpai. Kesan sungkupan ini dapat dilihat pada rumpai semusim apabila penggunaannya dicampurkan dengan metolachlor pada kadar 1.8 kg/ha. Kesan ke atas pengawalan rumpai saka dapat dilihat dengan meningkatkan penggunaan metolachlor pada kadar 3.6 kg/ha.

Aktiviti fitotoksik sungkupan OPEFB dan RS yang terdedah di ladang dikaji dengan menggunakan kaedah pengurangan pemanjangan akar anakbenih padi. Selepas lapan minggu, tiada kesan penggurangan pemanjangan akar yang berlaku ke atas sungkupan OPEFB dan RS pada kedua-dua kadar metolachlor.

Daripada kajian, didapati sungkupan OPEFB dapat meningkatkan peratus bahan organik tanah (10.6%), karbon organik (10.6%), fosforus (15.3%), kalium (49.9%) dan sedikit peningkatan peratus nitrogen (5.6%). Penggunaan tiga lapis sungkupan RS didapati menyumbangkan peratusan bahan organik tanah (9.3%), karbon organik (9.3%), kalium (73.8%) dan fosforus (18.7%) yang lebih tinggi berbanding dengan penggunaan selapis atau dua lapis sungkupan.

Berdasarkan keputusan kajian, dua rumusan dapat dicadangkan iaitu OPEFB yang dicampur dengan 3.6 kg/ha metolachlor berpotensi tinggi untuk digunakan bagi mengawal rumpai di sekelinling tanaman pokok renek dan pokok yang baru diubah ke ladang. Tiga lapisan jerami padi yang dicampurkan dengan 3.6 kg/ha metolachlor juga boleh digunakan dengan berkesan bagi mengawal rumpai di kawasan tanaman saka yang muda.

CHAPTER I

INTRODUCTION

Agriculture has to meet the challenges of the increasing demand for global food and fiber production in order to keep pace with the 2% rate of population growth, and meet the requirements of 10 billion people who will inhabit the world by the year 2050. Despite many remarkable advances in agricultural technology, agricultural production is significantly affected by pest damage. An average crop loss of 40% in potential yields to pest infestations has been estimated with 12% of the loss being due to weeds (Pimentel and Pimentel, 1997). Weeds affect the main crop directly by competing for nutrients, water and light and by allelopathy, and indirectly by interference with agronomic practices.

Conditions with high rainfall, temperature and humidity favour luxuriant growth of weeds. Hence, weeds are more serious throughout the humid tropics and subtropics and when poorly managed, they cause losses of between 25% and 100% of the harvest (Collins, 1991).

Herbicides have been the primary method of controlling weeds in agronomic crops since the early 1950's. Herbicides have been successfully used in regulating weed infestations but with some side effects and major impact on the environment.

This has created the need for new weed management strategies to improve weed control and protect the environment at the same time. Integrated weed management is one such strategy. In the tropics where temperatures, soil desiccation and rainfall are more intensive and soil structure is generally poor, integrated weed management is considered as the key strategy to manage weeds (Moody 1995; Akobundu, 1996; Labrada, 1996). Various approaches have been developed to improve weed and crop management. Among them the use of crop residue mulches has become increasingly important. Numerous authors have also considered the role of cover crops as a component of integrated weed management (Altieri and Liebman, 1988; Swanton and Weise, 1991; Liebman and Gallandt, 1997).

Mulches suppress weed emergence due to shading, low ambient temperature near the soil surface, release of phytotoxic chemicals or change in soil pH (Facelli and Picket, 1991; Van Rijn, 1991; Lindwall *et al.*, 1994). Other benefits of mulches include reduced soil erosion, increased water infiltration and soil moisture, improved soil structure and nutrient use and reduced fuel and labour requirements (Lal *et al.*, 1994; Worsham *et al.*, 1995).

The thickness and kind of mulch materials are critical in influencing weed emergence and development. Day (1968), reported that moderately thin layers of mulch control weeds that germinate near the soil surface, but even thick layers of mulch may not be effective in controlling certain perennial species. Mohlar and Tasdale (1993), have shown that natural field rate residues of previous crops was insufficient to control most weed species. Using varied levels of crop residues, many researchers indicated that annual weed infestation decreased as crop residue in the soil surface increased and for successful weed management, crop residue mulches should be used in combination with herbicides. Case studies have shown that with proper choice and manipulation of residues, it is often possible to reduce the number and/or the amount of herbicides needed (Chee *et al*., 1991; Worsham *et. al*., 1995).

However, findings have been mixed in studies examining efficacy of weed control and activity of herbicides as affected by retention of herbicides on crop residues and amount of rainfall following herbicide application. While several studies showed decrease in weed control and herbicide activity (Banks and Robinson, 1982; Monks and Banks, 1993; Walsh *et al*., 1993), others reported good weed control with herbicide even when large quantities of crop residue were present on the soil surface (Erbach and Lovely, 1975; Liebl and Worsham, 1983; Worsham *et al*., 1995).

In Malaysia, crop residues which can be easily and practically used as mulches are readily available in the form of rice straw, oil palm empty fruit bunches and other plant residues and by-products. With the universal task towards a clean environment and better agricultural sustainability by minimizing waste and recycling by-products, one hypothesis tested in the present study was that rice straw and oil palm empty fruit bunch fibres when processed into mats and used as mulch would provide effective weed control besides other benefits of mulch. This can improve agricultural sustainability and environmental quality by reducing dependence on herbicides.

The objectives of the research were:

1. To evaluate the effects of rice straw and oil palm empty fruit bunch fibre mats on weed control efficacy under two field situations with different cropping practices: (a) frequently cultivated annual crop production system, and (b) permanent mature orchard system with no tillage.
2. To evaluate herbicide activity as influenced by presence of mats.
3. To study the contribution of fibre mats to soil nutrient supply.

CHAPTER II

LITERATURE REVIEW

Impact of Weeds on Agriculture

Weeds have been defined as higher plants in the agroecosystems where they "are not sown", "are undesired", "out of place", or generally as "plants which do more harm than good". They lead to direct yield losses through competition with the crop for water, nutrients, light, space and/or carbon dioxide. In addition to competition some weeds contain inhibitory substances which inhibit the growth of main crops. Also weeds interfere negatively with cultural and harvest practices, may be poisonous or harbor pest and diseases (Braun *et al.*, 1991).

Extensive research into crop yield losses indicated that worldwide, a 12% loss of agricultural crop production is attributed to the competitive effect of weeds (Pimentel and Pimentel, 1997). In the humid tropics and subtropics with high rainfall, humidity and temperature, weeds may cause losses of between 25% and 100% of the harvest (Collins, 1991).

In Malaysia weeds constitute a serious and continuing limitation to agricultural production. In studying the competition of different weed groups with direct seeded rice, Azmi (1991) reported that reductions in yield due to grass weeds, broadleaf weeds and sedges were 41.1%, 28% and 10%, respectively. Weeds have been found to affect growth and yield of crops such as cassava, cocoyam, sweet potato, sugar cane, maize, groundnut and soybeans (Chee *et al.*, 1990).

Direct effects of weeds in tropical plantation crops include reduction in growth of 51 to 77% in two-month-old young rubber seedlings (Chee *et al.*, 1990), 7 to 13% reduction in the girth of rubber trees (Watson *et al.*, 1964) and yield reductions of 6 to 20% in oil palm (Gray and Hew, 1968) and 46.5 to 51.2% in cocoa (Chung and Lam, 1990).

Noxious Weed Species in Malaysia

In Malaysia noxious weeds in field crops were: *Amaranthus* spp, *Euphorbia* spp, *Imperata cylindrica*, *Ageratum conyzoides*, *Borreria latifolia*, *Asystasia intrusa*, *Eleusine indica*, *Cleome rutidosperma* and *Mikania micrantha* (Lee and Lo, 1988a; 1988b).

The most serious weeds in plantations of Malaysia as reported by Chee (1994) were: *A. gangetica*, *M. micrantha*, *B. latifolia*, *I. cylindrica*, *Ischaemum muticum*, *Ottochloa nodosa*, *Paspalum conjugatum* and *Pennisetum polystachion*.