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USING SEAWATER FOR WEED MANGEMENT IN TURFGRASS

MD. KAMAL UDDIN

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USING SEAWATER FOR WEED MANGEMENT IN TURFGRASS

BY

MD. KAMAL UDDIN

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MD. KAMAL UDDIN

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Chairman: Associate Professor Abdul Shukor Juraimi, PhD

Institute: Tropical Agriculture

Long term use of herbicide can pose serious threat to environment. Alternative strategies to chemical herbicide in weed control have received increasing attention now a days. Salty water could be used to control weed in salt tolerant turfgrass areas. A series of experiments were conducted to examine the response of turfgrass species, common local weed species and soil microbial communities to salinity stress both singly and in combination with reduced rates of recommended herbicides. The plant species selected for evaluation in these studies were based on a detailed preliminary survey conducted in local turfgrass areas.

Four salinity levels (0, 24, 48 and 72 dSm⁻¹) were imposed on 16 turfgrass entries in glasshouse experiments to identify potential salt tolerant turf species. Tolerance ranking was based on 50% reduction of shoot and root dry weights, leaf firing and turf quality. Predicted salinity levels for 50% shoot and root growth reductions were, 17.0 – 39.8 and



18.8 – 49.4 dS m⁻¹, respectively. *Paspalum vaginatum* proved to be superior in salt tolerance, and was closely followed by *Zoysia japonica* and *Zoysia matrella*.

In the field survey of four different turfgrass areas, 79 weed species belonging to 16 families were recorded. Maximum numbers of weed species were found on residential lawns, while least numbers were recorded on golf course putting greens; athletic fields and sod farms ranked intermediate. *Cyperus aromaticus* yielded the highest relative abundance value in golf course putting greens (71.5), followed by athletic fields (45.5) and residential lawns (21.7). *Fimbristylis dichotoma* and *Cyperus compressus* yielded the highest relative abundance values on residential lawns (35.0) and sod farms (30.4), respectively.

In studies evaluating the use of saline solutions for weed control, the same four salinity levels (0, 24, 48 and 72 dS m⁻¹) were applied to all 79 weed species, along with *P. vaginatum* (as a control). The results on injury ratings for salt tolerant weeds were categorized as highly susceptible, moderately susceptible and extremely tolerant. The results showed that 44 weed species were very susceptible and found to be effectively controlled (100%) at salinities of 24 and 48 dS m⁻¹, while 30 species were found to be effectively controlled with the 72 dS m⁻¹ salinity treatment. The five most serious weeds viz. *Eragrostis atrovirens*, *Sporobolus diander*, *Cyperus aromaticus*, *Cyperus rotundus* and *Emilia sonchifolia* were found to be extremely tolerant, and were not controlled even at the highest salinity level of 72 dS m⁻¹.



In the physiological study, three most tolerant and three least tolerant turf species were subjected to seven salinity levels (0, 8, 16, 24, 32, 40 and 48 dS m⁻¹) treatments and were assessed for leaf proline, chlorophyll and relative water contents. Leaf firing, plant biomass, and concentrations of Na, K, Ca, and Mg in shoots and roots were also determined. Root structure injury was observed under a scanning electron microscope (SEM). In general, trends of proline concentrations were found to increase with increasing salinity levels. However, there was an extremely higher rate of increase in salt tolerant species than in sensitive ones. *Zoysia japonica* was the least Na accumulating at all salinity levels followed by *P. vaginatum* and *Z. matrella*, while *D. didactyla* was the highest Na accumulating species followed by *Cynodon dactylon* ‘satiri’ and *Cynodon dactylon* ‘tifdrawf’. *Paspalum vaginatum* always had greater K contents at all salinity levels followed by *Z. japonica* and *Z. matrella*. On the other hand, the lowest K contents were recorded in *C. dactylon* ‘tifdwarf’ followed by *C. dactylon* ‘satiri’ and *D. didactyla*. Salinity caused root cortex cells to collapse, in *C. dactylon* ‘tifdwarf’, *C. dactylon* ‘satiri’ and *D. didactyla* at highest salinity level (48 dS m⁻¹), but not in *P. vaginatum*, *Z. japonica* and *Z. matrella*. Soil microbes were more or less affected by application of either herbicides, sea water or in combination. However, salt water treatment in combination with reduced herbicide are more eco-friendly than other options.

Sensitivity to seawater plus reduced rates of herbicide was evaluated for *E. atrovirens*, *S. diander*, *C. aromaticus*, *C. rotundus* and *E. sonchifolia* as well as for turfgrasses viz. *P. vaginatum*, *C. dactylon* ‘satiri’, and *Z. japonica*. The weed species *S. diander*, *C.*



aromaticus, *C. rotundus* and *E. sonchifolia* except *E. atrovirens* were fully controlled when treated with $\frac{3}{4}$ recommended trifloxysulfuron–sodium with sea water, $\frac{3}{4}$ recommended trifloxysulfuron–sodium with $\frac{3}{4}$ sea water, $\frac{1}{2}$ recommended trifloxysulfuron–sodium with sea water, $\frac{3}{4}$ recommended quinclorac with sea water and $\frac{3}{4}$ recommended quinclorac with $\frac{3}{4}$ sea water. *Eragrostis atrovirens* showed maximum 48% injury when treated with $\frac{3}{4}$ recommended trifloxysulfuron–sodium and sea water. Among the tested turfgrasses, *P. vaginatum* showed only 8% injury to sea water in combination with $\frac{3}{4}$ recommended quinclorac, indicating greater salt tolerance. *Zoysia japonica* also showed no more than 14% injury when treated with sea water in combination with $\frac{3}{4}$ recommended trifloxysulfuron–sodium or quinclorac. *Cynodon dactylon* ‘satiri’ had up to 21% salt injury with $\frac{3}{4}$ sea water in combination with $\frac{3}{4}$ recommended trifloxysulfuron –sodium.



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

**MENGGUNAKAN AIR LAUT UNTUK PENGURUSAN RUMPAI
DI KAWASAN RUMPUT TURF**

Oleh

MD. KAMAL UDDIN

September 2010

Pengerusi : Professor Madya Abdul Shukor Juraimi, PhD

Institut : Pertanian Tropika

Penggunaan racun rumput dalam jangka masa panjang memberikan kesan buruk kepada alam sekitar. Kini keadah alternatif kepada racun rumput dalam pengawalan rumput semakin mendapat perhatian. Air masin mungkin boleh digunakan untuk mengawal rumput bagi penanaman rumput turf yang toleran kepada kemasinan. Satu siri eksperimen telah dijalankan untuk menguji tindak balas spesies rumput turf, spesies rumput tempatan dan mikrob tanah terhadap tekanan kemasinan secara tunggal dan dalam kombinasi dengan racun rumput pada kadar rendah. Spesies tumbuhan yang dipilih untuk kajian ini adalah berdasarkan kepada keputusan kajian awal di kawasan rumput turf tempatan.

Di dalam eksperimen rumah kaca, 16 rumput turf telah dirawat dengan empat kadar kemasinan (0, 24, 48 dan 72 dS m⁻¹) untuk mengenalpasti spesies rumput turf yang tahan terhadap kemasinan. Tahap ketahanan adalah berdasarkan kepada 50%



pengurangan pertumbuhan pucuk dan akar, lecur daun dan kualiti rumput turf. Tahap kemasinan yang telah dijangka untuk 50% pengurangan pertumbuhan pucuk dan akar adalah masing-masing pada kadar 17.0-39.8 dan 18.8-49.4 dS m⁻¹. *Paspalum vaginatum* didapati lebih tahan kepada kemasinan diikuti oleh *Zoysia japonica* dan *Zoysia matrella*.

Bancian di lapangan mendapati 79 spesies rumput daripada 16 famili telah direkodkan di empat jenis kawasan rumput turf yang dikaji. Bilangan spesies rumput paling tinggi telah dicatatkan di laman kawasan perumahan manakala spesies rumput paling rendah didapati di 'putting green' Padang golf; bilangan spesies di padang olahraga dan nurseri turf adalah sederhana. *Cyperus aromaticus* mencatatkan populasi relatif yang paling tinggi di kawasan 'putting green' (71.5) diikuti dengan padang olahraga (45.5) dan laman kawasan perumahan (21.7). Populasi relatif paling tinggi bagi *Fimbristylis dichotoma* dan *Cyperus compressus* terdapat di kawasan perumahan (35.0) diikuti dengan nurseri turf (30.4).

Dalam kajian pengawalan rumput menggunakan air masin, kesemua empat kadar kemasinan yang sama (0, 24, 48 dan 72 dS m⁻¹) di uji ke atas kesemua 79 spesies rumput dan *Paspalum vaginatum* yang dijadikan sebagai kawalan. Rumput di bahagikan kepada tiga kumpulan berdasarkan kepada tahap kecederaan, iaitu tidak tahan masin, sederhana tahan dan paling tahan. Keputusan kajian menunjukkan 44 spesies rumput yang sangat tidak tahan terhadap kemasinan dapat dikawal secara berkesan (100%) pada kadar 24 dan 48 dS m⁻¹, manakala 30 spesies dapat dikawal secara berkesan hanya pada kadar 72 dS m⁻¹. Lima spesies rumput yang paling serius iaitu *Eragrostis atrovirens*, *Sporobolus*

diander, *Cyperus aromaticus*, *Cyperus rotundus* dan *Emilia sonchifolia* dikenal pasti sebagai yang paling tahan kerana tidak dapat dikawal walaupun pada kadar kemasinan yang paling tinggi iaitu 72 dS m⁻¹.

Dalam kajian fisiologi, tujuh kadar kemasinan (0, 8, 16, 24, 32, 40 dan 48 dS m⁻¹) telah digunakan ke atas tiga spesies rumput turf paling tahan dan tiga spesies yang paling tidak tahan kemasinan dengan menilai kandungan prolin, klorofil dan relatif air daun. Lecur daun, biomass, kepekatan Na, K dan Mg pucuk dan akar juga di tentukan. Kecederaan struktur akar diamati menggunakan mikroskop pengimbas elektron. Pada umumnya, kepekatan prolin meningkat selari dengan peningkatan kadar kemasinan. Semakin tahan spesies rumpai terhadap kemasinan, semakin tinggi kandungan prolin. Pengumpulan Na paling rendah pada semua kadar kemasinan di catatkan oleh *Z. japonica* diikuti dengan *P. vaginatum* dan *Z. matrella*, sementara *D. didactyla* mempunyai kandungan Na paling tinggi diikuti dengan *C. dactylon* 'satiri' dan *C. dactylon* 'tifdwarf'. *P. vaginatum* adalah spesies paling tinggi kandungan K pada semua kadar kemasinan, diikuti oleh *Z. japonica* dan *Z. matrella*, manakala kandungan K paling rendah adalah pada spesies *C. dactylon* 'tifdwarf' diikuti dengan *C. dactylon* 'satiri', dan *D. didactyla*. Kemasinan tinggi (48 dS m⁻¹) telah memusnahkan sel kortek akar rumput turf *C. dactylon* 'tifdwarf', *C. dactylon* 'satiri' dan *D. didactyla*, kecuali species *P. vaginatum*, *Z. japonica* dan *Z. matrella*. Penggunaan racun rumpai air laut atau kombinasi kedua-duanya didapati mempengaruhi kehadiran mikrob tanah. Walau bagaimanapun, kombinasi air laut dengan racun rumpai kadar rendah didapati lebih mesra alam berbanding pilihan lain.

Kajian kepekatan terhadap kombinasi air laut dan racun rumput kadar rendah telah dilakukan ke atas spesies rumput *E. atrovirens*, *S. diander*, *C. aromaticus*, *C. rotundus* and *E. sonchifolia* dan rumput turf *P. vaginatum*, *C. dactylon* 'satiri', and *Z. japonica*. Keputusan kajian menunjukkan kesemua spesies rumput kecuali *E. atrovirens* dapat dikawal sepenuhnya apabila dirawat dengan campuran $\frac{3}{4}$ daripada kadar disyorkan racun rumput trifloxysulfuron–sodium bersama air laut, $\frac{3}{4}$ daripada kadar disyorkan racun rumput trifloxysulfuron–sodium bersama $\frac{3}{4}$ kadar air laut, $\frac{1}{2}$ daripada kadar disyorkan racun trifloxysulfuron–sodium bersama air laut, $\frac{3}{4}$ daripada kadar disyorkan racun rumput quinclorac bersama air laut dan $\frac{3}{4}$ daripada kadar disyorka racun rumput quinclorac bersama $\frac{3}{4}$ air laut. *Eragrostis atrovirens* menunjukkan kecederaan paling maksima 48% apabila dirawat dengan $\frac{3}{4}$ daripada kadar disyorkan racun rumput trifloxysulfuron–sodium bersama air laut. Di antara spesies rumput turf yang telah diuji, *P. vaginatum* menunjukkan ketahanan yang tinggi terhadap air laut dan kombinasi air laut dan $\frac{3}{4}$ daripada kadar racun rumput quinclorac disyorkan, dengan nilai kecederaan paling maksimum hanya 8%. *Zoysia japonica* pula menunjukkan kecederaan yang tidak lebih dari 14% apabila di rawat dengan air laut atau kombinasi air laut bersama $\frac{3}{4}$ daripada kadar racun rumput trifloxysulfuron–sodium atau quinclorac disyorkan. Kecederaan maksimum iaitu 21% telah dicatatkan oleh *C. dactylon* 'satiri' dengan kombinasi $\frac{3}{4}$ kadar air laut dan $\frac{3}{4}$ kadar racun rumput trifloxysulfuron–sodium disyorkan.



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I certify that an Examination Committee has met on 2 September, 2010 date of viva voce to conduct the final examination of Md. Kamal Uddin on his Doctor of Philosophy thesis entitled “Using Seawater for Weed Management in Turfgrass” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15th March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Examination Committee were as follows:

Adam b Puteh, PhD

Associate Professor
Department of Crop Science
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Rosli b Mohamad, PhD

Professor
Department of Crop Science
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Yahya bin Awang, PhD

Associate Professor
Department of Crop Science
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Jahid Ata Cheema, PhD

Professor
Department of Agronomy
University of Agriculture, Faisalabad
Pakistan
(External Examiner)

SHAMSUDDIN SULAIMAN, PhD

Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia
Date: 26 November 2010



This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement of the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Abdul Shukor Juraimi, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Mohd Razi Ismail, PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Anuar Abd. Rahim, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Radziah Othman, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

HASANAH MOHD GHAZALI, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia
Date:



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 Universiti Putra Malaysia or other institutions.

MD. KAMAL UDDIN

Date:



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