



**UNIVERSITI PUTRA MALAYSIA**

**EVALUATION OF SALT TOLERANCE IN TURFGRASS SPECIES OF  
PENINSULAR MALAYSIA**

**NOOR AZWA ZULKALIPH @ ZULKIFLI**

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EVALUATION OF SALT TOLERANCE IN TURFGRASS SPECIES OF  
PENINSULAR MALAYSIA

By

NOOR AZWA ZULKALIPH @ ZULKIFLI

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia in  
Fulfilment of the Requirements for the Degree of Master of Science

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## DEDICATION

*This work is dedicated to the loving and sacred memory of my father, Zulkaliph @ Zulkifli Elias, who left me forever on 1<sup>st</sup> Rejab 1432 H, to my endless love mother, Norsiah Kassim, my beloved husband, Mohd Shahrul Usran and all my loving family members*



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of  
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**April 2013**

**Chairman: Professor Abdul Shukor Juraimi, PhD**

**Faculty: Agriculture**

Demand for salt tolerant turfgrass species is increasing in Malaysia due to shortage of fresh irrigation water and salt water intrusion in seashore area. The aim of this research was to evaluate salinity tolerance of turfgrass species across Peninsular Malaysia. The specific objectives of this study were (i) to screen the salinity tolerance of local turfgrass entries in Peninsular Malaysia, (ii) to study the morphological and physiological responses of turfgrass species to salinity stress, and (iii) to evaluate the growth performance of salt tolerant turfgrass species in the field condition.

Turfgrass species were collected from the coastal areas of Peninsular Malaysia. A total of 34 turfgrass entries were screened in the first experiment. This experiment was carried out in glasshouse and four different salinity levels [0 (control), 24, 48 (100% seawater), and 72 dS m<sup>-1</sup>] were used to irrigate the turfgrasses. All the entries of turfgrasses were grouped for salinity tolerance on the basis of shoot and root growth, leaf firing, turf colour index and turf quality. Regardless of the species or entries,

increasing the salinity levels had increased the percentage of leaf firing, decreased turf colour index, turf quality, relative shoot growth and root growth. The most tolerant species group comprised of *P. vaginatum* (16)\*, *P. vaginatum* ‘local’, *Z. matrella*, *Z. japonica*, *C. dactylon* ‘satiri’ , *C. dactylon* (9)\* which were able to tolerate high levels of salinity ( $24$  to  $48$  dS m $^{-1}$ ). While, the least tolerant group were *E. ophiuroides*, *P. notatum*, *A. compressus* ‘cowgrass’, *A. affinis*, and *A. compressus* ‘pearl blue’ which were affected at salinity levels of  $24$  dS m $^{-1}$ .

The morphological and physiological mechanisms for salt tolerant turfgrass species were studied in the second experiment. Based on the findings of first experiment, three most salt-tolerant species (*P. vaginatum*, *Z. matrella* and *C. dactylon* ‘satiri’) and one medium salt-tolerant turfgrass species (*C. dactylon* ‘tifdwarf’) were selected for this experiment. These species were subjected to five salinity levels ( $0$ ,  $12$ ,  $24$ ,  $36$  and  $48$  dS m $^{-1}$ ). Physiological data recorded in this experiment were chlorophyll concentration, leaf proline accumulation, relative water content, and mineral analysis of Na, N, P, K, Ca and Mg. Growth parameters (leaf firing, turf quality, turf colour index, shoot growth and root growth) were also determined. The presence of salt gland and root cortex structure were observed under scanning electron microscope (SEM). Growth responses and the physiological data had indicated that *P. vaginatum*, *Z. matrella* and *C. dactylon* ‘satiri’ were more salt tolerant than *C. dactylon* ‘tifdwarf’. Leaf proline concentration of all turfgrass species were sharply increased while chlorophyll concentration and relative water content (RWC) decreased in response to increasing the salinity level. The high salt tolerant turfgrass species (*P. vaginatum*, *Z. matrella* and *C. dactylon* ‘satiri’) were

\* Numbers in the brackets denote entry number as listed in Table 3.1

able to maintain the high level of chlorophyll content compared to *C. dactylon* ‘tifdwarf’. The *P. vaginatum* and *Z. matrella* have the ability to preserve osmotic adjustment indicated by relative water content and proline accumulation even at the highest salinity treatment ( $48 \text{ dS m}^{-1}$ ). These species were less affected by salinity on selective uptake of saline ion (Na) uptake and with minimal interference of nutrient function and uptake (N, P, K, Ca and Mg) at high salinity levels. The SEM study revealed the presence of salt gland excretion in *Z. matrella*, *C. dactylon* ‘satiri’ and *C. dactylon* ‘tifdwarf’ leaves and it was one of the mechanisms operating for adaptation to salinity. The collapsed root cortex cells of *C. dactylon* ‘tifdwarf’ due to salinity stress were higher compared to other three species.

The performances of three high salt tolerant species (*P. vaginatum*, *Z. matrella* and *C. dactylon* ‘satiri’) in the second experiment were then examined under field conditions. Five different salinity levels (0, 12, 24, 36 and  $48 \text{ dS m}^{-1}$ ) were applied to these species on daily basis. Eight parameters were recorded namely leaf firing, turf colour index, turf quality, shoot density, shoot growth, root growth, and root volume. It was found that *P. vaginatum* showed the highest performance on saline irrigation compared to *Z. matrella* and *C. dactylon* ‘satiri’. The *P. vaginatum* showed least leaf firing (5%) with better turf quality (8.33 rating) and it was able to maintained good green colour (6.94 turf colour index) when irrigated with sea water ( $48 \text{ dS m}^{-1}$ ). The root growth and root volume of this species was increased with the increasing salinity up to  $24 \text{ dS m}^{-1}$  compared to other two species. Salinity tolerance ranking of the tested species was found as: *P. vaginatum* > *Z. matrella* > *C. dactylon* ‘satiri’.

From this study it may be concluded that *P. vaginatum* was the most salt tolerant species followed by *Z. matrella* and *C. dactylon* ‘satiri’. These turf grass species could be viable and cost effective, and they can be used as the alternative solutions for the problems of salt affected area.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

## **PENILAIAN TERHADAP SPESIES RUMPUT TURF TAHAN KEMASINAN DI SEMENANJUNG MALAYSIA**

Oleh

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**April 2013**

**Pengerusi: Profesor Abdul Shukor Juraimi, PhD**

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Permintaan terhadap spesies rumput turf yang tahan kemasinan semakin meningkat di Malaysia disebabkan oleh kekurangan air bersih untuk pengairan dan gangguan kemasukan air masin di kawasan tepi laut. Tujuan kajian ini diadakan adalah untuk menilai toleransi kemasinan spesies rumput turf dari seluruh Semenanjung Malaysia. Objektif kajian ini adalah (i) Untuk menyaring tahap toleransi kemasinan dalam spesies rumput turf di Semenanjung Malaysia (ii) Untuk mengkaji tindak balas morfologi dan fisiologi spesies rumput turf terhadap kemasinan, dan (iii) Untuk menilai prestasi rumput turf yang tahan kemasinan di bawah keadaan lapangan.

Spesies rumput turf di ambil dari kawasan persisiran pantai di seluruh Semenanjung Malaysia dikenal pasti dan dikumpulkan. Sebanyak 34 entri rumput turf telah disaring dalam eksperimen ini. Eksperimen ini dijalankan di rumah kaca dan empat tahap kemasinan yang berbeza kepekatan (0, 24, 48 (100% air laut) dan 72 dS m<sup>-1</sup>) digunakan

sebagai pengairan rumput turf. Spesies rumput turf dikumpulkan mengikut tahap toleran kemasinan berdasarkan pertumbuhan pucuk dan akar, lecur daun, indeks warna turf dan kualiti turf. Tanpa mengira spesies atau entri, peningkatan tahap kemasinan meningkatkan peratusan daun lecur, mengurangkan indeks warna turf, kualiti turf, relatif pertumbuhan pucuk dan akar. Kumpulan spesies yang paling toleran terdiri daripada *P. vaginatum* (16)\*, *P. vaginatum* 'local', *Z. matrella*, *Z. japonica*, *C. dactylon* 'satiri', *C. dactylon* (9)\* yang mampu untuk toleransi terhadap tahap kemasinan yang tinggi (24 hingga 48 dS m<sup>-1</sup>). Kumpulan yang kurang toleransi terdiri daripada *E. ophiuroides*, *P. notatum*, *A. compressus*, *A. affinis* dan *A. compressus* 'mutiara biru' yang telah terjejas pada tahap kemasinan 24 dS m<sup>-1</sup>.

Morfologi dan mekanisma fisiologi pada spesies rumput turf yang toleran terhadap kemasinan dikaji dalam eksperimen kedua. Berdasarkan dapatan pada eksperimen pertama, tiga spesies rumput turf yang paling toleran terhadap kemasinan (*P. vaginatum*, *Z. matrella* and *C. dactylon* 'satiri') dan satu spesies rumput turf yang medium toleran pada kemasinan (*C. dactylon* 'tifdwarf') telah dipilih untuk eksperimen ini. Spesies-spesies ini didedahkan kepada lima tahap kemasinan (0, 12, 24, 36 dan 48 dS m<sup>-1</sup>). Parameter fisiologi yang direkodkan dalam eksperimen ini adalah kepekatan klorofil, pengumpulan prolin daun, kandungan air relatif dan analisis mineral Na, N, P, K, Ca dan Mg. Parameter pertumbuhan (lecur daun, kualiti turf, indeks warna turf dan pertumbuhan pucuk dan akar) juga ditentukan. Kehadiran kelenjar garam dan struktur korteks akar diperhatikan di bawah mikroskop imbasan elektron (SEM). Tindak balas pertumbuhan dan fisiologi menunjukkan *P. vaginatum*, *Z. matrella* and *C. dactylon*

\* Nombor di dalam kurungan menunjukkan number entri seperti yang disenaraikan dalam Jadual 3.1

‘satiri’ lebih toleran pada kemasinan berbanding *C. dactylon* ‘tifdwarf’. Kepekatan prolin dalam daun semua spesies rumput turf meningkat secara mendadak, manakala kepekatan klorofil dan kandungan air relatif (RWC) menurun sebagai tindak balas terhadap meningkatnya tahap kemasinan. Spesies rumput turf yang tinggi toleransi kemasinan (*P. vaginatum*, *Z. matrella* and *C. dactylon* ‘satiri’) mempunyai keupayaan untuk mengekalkan penyesuaian osmotik yang ditentukan dari kandungan air relatif dan pengumpulan prolin walaupun dirawat dengan tahap kemasinan yang paling tinggi (48 dS m<sup>-1</sup>). Selain itu, ketiga-tiga spesies ini kurang terjejas dalam pemilihan pengambilan ion masin (Na) dengan minimum gangguan fungsi dan penyerapan nutrien (N, P, K, Ca dan Mg) apabila dirawat dengan tahap kemasinan yang paling tinggi. Kajian SEM mendedahkan kehadiran kelenjar perkumuhan garam pada daun *Z. matrella*, *C. dactylon* ‘satiri’ dan *C. dactylon* ‘tifdwarf’ sebagai salah satu operasi mekanisme untuk adaptasi kepada kemasinan. Sel-sel korteks akar yang musnah pada *C. dactylon* ‘tifdwarf’ disebabkan oleh kemasinan adalah lebih tinggi berbanding dengan tiga spesies yang lain.

Prestasi tiga spesies toleran kemasinan yang tinggi (*P. vaginatum*, *Z. matrella* and *C. dactylon* ‘satiri’) dalam eksperimen kedua kemudiannya diuji di lapangan. Lima tahap kemasinan air pengairan yang berbeza (0, 12, 24, 36 and 48 dS m<sup>-1</sup>) telah disiram kepada spesies ini setiap hari. Lapan parameter direkodkan iaitu lecur daun, indeks warna turf, kualiti turf, kepadatan pucuk, pertumbuhan pucuk, pertumbuhan akar dan isipadu akar. Hasil kajian mendapat *P. vaginatum* menunjukkan prestasi tertinggi dengan pengairan air masin di lapangan berbanding *Z. matrella* dan *C. dactylon* 'satiri'.

*P. vaginatum* menunjukkan lekur daun yang sangat rendah (5%), kualiti turf yang lebih baik (tahap 8.33) dan dapat mengekal warna hijau yang cantik (6.94 indeks turf warna) apabila disiram dengan air laut ( $48 \text{ dS m}^{-1}$  kemasinan). Pertumbuhan akar dan jumlah akar spesis ini meningkat dengan peningkatan tahap kemasinan kepada  $24 \text{ dS m}^{-1}$  berbanding dengan dua spesies yang lain. Kedudukan tahap toleransi kemasinan spesies diuji adalah: *P. vaginatum* > *Z. matrella* > *C. dactylon* 'satiri'.

Dari kajian ini, boleh disimpulkan bahawa *P. vaginatum* adalah spesies yang paling toleran terhadap kemasinan diikuti dengan *Z. matrella* dan *C. dactylon* 'satiri'. Rumput-rumput turf ini mampu berdaya saing, kos efektif dan penyelesaian alternatif kepada kawasan yang ada masalah kemasinan.

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I certify that a Thesis Examination Committee has met on 23 April 2013 to conduct the final examination of Noor Azwa binti Zulkaliph @ Zulkifli on her thesis entitled "Evaluation of Salt Tolerance in Turfgrass Species of Peninsular Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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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 Universiti Putra Malaysia or any other institution.

**NOOR AZWA ZULKALIPH @ ZULKIFLI**

Date: 23 April 2013



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