COMPETITION EFFECTS OF PURPLE NUTSEDGE (*Cyperus rotundus* L.) ON GROWTH AND YIELD OF TEF (E*ragrostis tef* (Zucc.) Trotter) IN ETHIOPIA

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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Dedicated to

My Wife Samia

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy

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Tef [*Eragrostis tef* (Zucc.) Trotter] is the staple food of Ethiopians, and purple nutsedge (*Cyperus rotundus* L.) is one of the commonest and most abundant weeds in tef. Thus, two experiments were undertaken at three locations, namely, Alem Tena, Debre Zeit and Tullu Bollo in Ethiopia to investigate competition effects of purple nutsedge on tef and determine combinations of seeding rates, sowing dates, fertilizer rates and time of weeding for effective control of nutsedge without the use of herbicides. The first experiment in each of the three locations consisted of three levels of tef seeding rates (10, 30 and 50 kg ha^{-1}), fertilizer at rates of 0, 10 & 20 kg N ha^{-1} and 0, 10.5 & 21 kg P ha^{-1}, in the form of Diammonium Phosphate (DAP) treatments, and nutsedge density

(0, 30 and 60 plants m^{-2}). The experiment was 3^3 factorial in a completely randomized block design with four replicates. The second experiment consisted of three sowing dates delayed by 0, 7 and 15 days and five weed removal treatments (no-weeding, weeded at 2, 4 & 6 weeks after crop emergence and a weed-free check). It was a 3x5 factorial in a completely randomized block design with four replications. The results obtained from this study indicated that tef was more competitive than nutsedge under conditions of stress at low soil fertility and high crop and weed densities. Tef plants under these conditions had fewer tillers, were much taller and produced higher yields. Highest seed rate of 50 kg ha^{-1} offered a greater competitive advantage to tef. The higher tef seeding rates were associated with higher biomass production, which was strongly and positively correlated with higher grain yield. Under conditions of higher soil fertility with applied fertilizer, purple nutsedge resulted in slightly more aggressive growth and reduced tef plant height and grain yield. A detailed analysis of the specific responses in tef plant height to nutsedge density and biomass in relation to fertilizer levels, tef seeding rates and nutsedge sowing densities showed that at the highest seed rate of 50 kg ha^{-1} tef was more competitive. There was a stronger trend in tef height increase with an increase in nutsedge density, and there was a strong positive correlation between tef plant height and grain yield (R^2=0.75). The data also showed that conditions favoring increase in tiller production was associated with lower grain yield. Increase in panicle length was associated with an increase in spikelet numbers and a corresponding increase in tef grain yields, provided there was no delay in

sowing. Sowing delays resulted in shorter panicles, and sowing delays of 7 and 15 days resulted in yield reductions of 59.60 and 68.39%, respectively. In general, tef was more competitive than purple nutsedge at all three experimental sites. In summary, crop seeding rates of between 30 and 50 kg ha^{-1}, fertilizer rates of 10 & 20 kg N ha^{-1} and 10.5 & 21 kg P ha^{-1}, and keeping the tef field free of weeds for at least six weeks and early sowing of tef would enhance farm yields. However, the prevailing environmental conditions may have also favored the survival and more aggressive growth of tef compared to nutsedge, probably due to the remarkable tolerance of tef to low moisture stress than nutsedge. Therefore, the competitiveness of tef against nutsedge needs to be further investigated under more favorable soil moisture conditions.

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

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Tef [*Eragrostis tef* (Zucc.)] merupakan makanan utama orang-orang Ethiopia dan *Cyperus rotundus* pula merupakan salah satu rumpai biasa dan paling banyak di kawasan tef. Dua kajian telah dijalankan di tiga kawasan iaitu Debre Zeit, Alem Tena dan Tullo Bollo untuk mengkaji kesan persaingan *Cyperus rotundus* terhadap tef dan juga untuk menentukan kombinasi kadar biji benih ditanam, tarikh menanam, kadar baja dan masa merumpai untuk kawalan *Cyperus rotundus* yang efektif tanpa menggunakan herbisid. Eksperimen pertama yang dilakukan di ketiga-tiga lokasi merangkumi tiga kadar biji benih ditanam (10, 30 dan 50 kg ha^{-1}), rawatan baja (0, 50 dan 100 Diammonium fosfat) dan densiti *C. rotundus* (0, 30 dan 60 pokok m^{-2}) menggunakan

rekabentuk factorial 3^3 dengan empat replikasi. Eksperimen kedua pula merangkumi tiga tarikh menyemai (0, 7 dan 15 hari lewat berbandig yang disyorkan) dan lima rawatan merumpai (0, 2, 4 dan 6 minggu selepas penanaman dan satu pemeriksaan tanpa merumpai). Experimen ini menggunakan rekabentuk faktorial 3x5 dengan empat replicasi. Keputusan kajian mendapati tef lebih kompetitif berbanding *Cyperus rotundus* dalam keadaan tekangan iaitu pada kesuburan tanah yang rendah dan densiti tef dan *Cyperus rotundus* yang tinggi. Tef dalam keadaan ini mempunyai tiler yang sedikit, tumbuh lebih tinggi dan mempunyai hasil yang lebih banyak. Kadar biji benih ditanam yang tertinggi (50 kg ha^{-1}) menjadikan tef lebih kompetatif. Dalam keadaan ini tef didapati menghasilkan biomas yang paling tinggi dan mempunyai korelasi positif yang kuat ke atas hasil bijirin tef. Dalam keadaan kesuburan tanah yang tinggi oleh rawatan pembajaan, *C. rotundus* didapati agak agrasif menyebabkan ketinggian dan hasil bijirin tef berkurangan. Analisis mendalam mengenai tindakbalas spesifik tinggi pokok tef terhadap biomas dan densiti *Cyperus rotundus* yang berkaitan dengan kadar baja, kadar biji benih tef ditanam dan densiti *Cyperus rotundus* yang ditanam menunjukkan kadar kepadatan tef yang tinggi (50 kg^{-1}) telah menghasilkan tef yang lebih kompetatif. Terdapat tren yang kuat ke atas peningkatan ketinggian tef dengan peningkatan densiti *Cyperus rotundus* dan juga terdapat korelasi positif yang kuat antara ketinggian tef dengan hasil bijirin. Data juga menunjukkan keadaan yang menyebabkan peningkatan tiler akan juga menyebabkan penurunan hasil bijirin. Peningkatan panjang panikel berkait rapat dengan peningkatan bilangan

spikelet yang seterusnya meningkatkan hasil bijirin tef dengan syarat penanaman tef dilakukan awal tanpa tangguh. Penanguhan masa menanam menghasilkan panikel yang lebih pendek dan penangguhan menanam selama 7 dan 15 hari menyebabkan penurunan hasil sebanyak 59.6 dan 68.39% setiap satu. Secara umumnya tef didapati lebih kompetatif berbanding *C. rotundus* di ketiga-tiga lokasi kajian. Secara ringkasnya kadar densiti tef yang ditanam antara 30 hingga 50 kg ha^{-1}, kadar pembajaan antara 50 – 100 kg ha^{-1}, kawalan rumpai dalam masa empat minggu selepas menanam, dan tarikh menanam tef yang lebih awal telah meningkatkan hasil tef. Walau bagaimanapun keadaan persekitaran juga didapati menyebabkan tef lebih sesuai hidup dan lebih agresif berbanding *C. rotundus,* mungkin disebabkan tef lebih toleran terhadap tekanan kelembapan yang rendah berbanding *C. rotundus*. Kajian lanjut perlu dilakukan untuk mengkaji keupayaan persaingan tef terhadap *C. rotundus* pada kelembapan tanah yang lebih tinggi.

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I certify that an Examination Committee met on 4th of November,2004 to conduct the final examination of Ahmed Mohammed Sherif on his Doctor of Philosophy thesis entitled "Competition Effects of Purple Nutsedge (*Cyperus rotundus* L.) on Growth and Yield of tef [E*ragrostis tef* (Zucc.) Trotter] in Ethiopia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 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 degree at UPM or other institutions.

_____

AHMED MOHAMMED SHERIF

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