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COMPATIBILITY OF FOUR FORAGE LEGUMES WITH GUINEA GRASS (Panicum maximum Jacq.)

MOHAMMED BABA

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By

MOHAMMED BABA

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

December 2013

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DEDICATION

To my loving parents, wife and daughters

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

COMPATIBILITY OF FOUR FORAGE LEGUMES WITH GUINEA GRASS (*Panicum maximum*) JACQ

By

MOHAMMED BABA
December 2013

Chairman : Associate Professor Mohd Ridzwan Abd Halim, PhD
Faculty : Agriculture

Livestock production in the tropics is constrained by decline in quantity and quality of the predominant tropical grasses during the growing season. Incorporation of forage legumes into grassland agriculture has been used as a panacea to mitigate the problem. However, in tropical regions, not much of success has been achieved due to strong competitive ability of the grass which reduces the content of the companion legume. It is with this background that four experiments were conducted to evaluate the compatibility of grass-legume mixtures and their suitability for plantation livestock integration.

An investigation into the nature of competition between *Panicum maximum* (guinea grass) and each of the following legumes of contrasting growth habits; *Stylosanthes guianensis* (stylo), *Centrosema pubescens* (centro) *Macroptilium bracteatum* (burgundy) and *Arachis pintoi* (arachis) showed that dry matter yield in guinea-centro mixtures (2:2 and 3:1) species combination tended to be higher than the corresponding grass monoculture (differences were not significant). Mean relative yield total values were higher in guinea-stylo (1.41) and guinea-centro (1.4) the values seemed to be higher at 2:2 species combination except in the case of guinea-burgundy. The climbing/trailing legume (centro) appeared to be more compatible with guinea grass especially at 2:2 species combination compared to the erect (stylo), erect/climbing (burgundy) and prostrate (arachis) legumes.

Compatibility of forage mixtures evaluated at 50:50 species combination in relation to dry matter yield and chemical composition indicates that guinea-arachis produced significantly greater ($P<0.01$) cumulative total dry matter yield compared to other mixtures. However, the yield was not significantly different from that of guinea monoculture. The erect legume (stylo) produced significantly higher ($P<0.01$) cumulative total dry matter yield than arachis in mixture with guinea. Similarly, relative yield of stylo tended to be higher than those of arachis and burgundy. Thus as a compromise between dry matter yield and pasture quality, grass-stylo mixture was recommended.

The productivity of four mixtures guinea-arachis, guinea-burgundy, guinea-centro and guinea-stylo evaluated under 3 shade levels 0 (1701.9µmol m^{-2} s^{-1}), 50 (583.3 µmol m^{-2} s^{-1}) and 70% (520.2 µmol m^{-2} s^{-1}) indicates that guinea-centro tended to produce higher yield among mixtures though differences were not significant. Centro in mixture with guinea recorded significantly higher yield ($P<0.05$) than arachis and burgundy. Interaction between legume species and shade levels on dry matter yield showed that the dry matter yields of centro and stylo were significantly greater than those of arachis and burgundy under 0% shade, however, centro recorded significantly higher yield than all legumes at 50% shade, a similar trend was observed at 70% shade but the difference was only significant when centro was compared with arachis. The dry matter yields of grass and legumes decreased with increasing shade level. Guinea-centro mixture was recommended based on higher dry matter yield of centro compared to other legumes especially at 50% shade.

Allelopathy study conducted using laboratory bioassay and pot trial to test whether guinea grass had allelopathic effect on companion legumes indicates that shoot length in stylo was significantly ($P<0.05$) reduced at 1% leaf extract concentration. Dry matter yield and root length in burgundy were significantly decreased by root powder while the yields of centro and stylo were enhanced by leaf powder. In conclusion, the climbing/trailing legume (centro) was observed to be the most compatible with guinea. This is based on the facts that in study 1, guinea-centro mixture showed tendency towards higher dry matter yield than the corresponding monoculture of grass (guinea). In study 2, however, the guinea-centro mixture was not part of the treatments owing to lack of germination of the centro seeds. In study 3, centro produced significantly higher dry matter yield than arachis and burgundy and surpassed other legumes at 50 % shade. Centro was also not negatively affected by the allelopathic effect of guinea grass as observed in study 4.

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

KESERASIAN CAMPURAN EMPAT KEKACANG FORAJ DENGAN RUMPUT GUINEA (*Panicum maximum*) JACQ

Oleh
MOHAMMED BABA
Disember 2013

Pengerusi : Profesor Madya Mohd Ridzwan Abd Halim, Ph.D
Fakulti : Pertanian

Pengeluaran ternakan di kawasan tropika dikekang oleh penurunan dalam kuantiti dan kualiti rumput tropika utama semasa musim yang semakin meningkat. Penubuhan kekacang makanan ternakan ke padang rumput pertanian telah digunakan sebagai penawar untuk menyelesaikan masalah tersebut. Walau bagaimanapun, di kawasan-kawasan tropika, tidak banyak kejayaan yang telah dicapai kerana kemampuannya kompetitif kuat rumput yang mengurangkan kandungan kekacang teman. Ia adalah dengan latar belakang ini bahawa empat percubaan telah dijalankan untuk menilai keserasian campuran rumput kekacang dan kesesuaiannya untuk integrasi ternakan perladangan.

Siasatan ke atas sifat persaingan antara *Panicum maximum* (rumput guinea) dengan setiap satu daripada kekacang berikut yang berlainan tabiat pertumbuhan; *Stylosanthes guianensis* (Stylo), *Centrosema pubescens* (centro) *Macroptilium bracteatum* (burgundy bean) dan *Arachis pintoi* (arachis) menunjukkan bahawa hasil kering campuran guinea-entro (2:2 dan 3:1) gabungan spesies cenderung untuk menjadi lebih tinggi daripada monokultur rumput (perbezaan ini tidak ketara). Hasil relatif jumlah adalah lebih tinggi dalam campuran guinea-stylo (1.41) dan guinea-centro (1.4) pada nisbah 2:2 kecuali untuk guinea-burgundy. Kekacang yang memanjat (centro) kelihatan lebih serasi dengan rumput guinea terutamanya pada kombinasi 2:2 berbanding yang tegak (stylo), tegak/memanjat (burgundy) dan yang melata (Arachis).

Keserasian campuran foraj dinilai pada nisbah 50:50 gabungan spesies dari segi hasil kering dan komposisi kimia menunjukkan bahawa guinea-arachis lebih tinggi hasil ($P<0.01$) terkumpul berbanding campuran lain. Walau bagaimanapun, hasil ini tidak ketara berbeza dengan guinea monokultur. Kekacang menegak (stylo) mempunyai hasil lebih tinggi ($P< 0.01$) daripada Arachis dalam campuran dengan guinea. Begitu juga, hasil relatif stylo cenderung untuk menjadi lebih tinggi daripada arachis dan burgundy. Oleh itu sebagai satu kompromi di antara hasil bahan kering dan kualiti, campuran rumput Stylo disyorkan.

Produktiviti empat campuran guinea-Arachis, guinea-burgundy, guinea-centro dan guinea-stylo dinilai di bawah 3 aras naungan 0 (1701.9 μmol m^{-2} s^{-1}), 50 (583.3 μmol m^{-2} s^{-1}) dan 70 % (520.2 μmol m^{-2} s^{-1}) menunjukkan bahawa guinea-centro cenderung

untuk mengeluarkan hasil yang lebih tinggi di kalangan campuran walaupun perbezaan ini tidak ketara . Centro dalam campuran dengan guinea mencatatkan hasil lebih tinggi ($P< 0.05$) daripada Arachis dan burgundy. Interaksi antara spesies kekacang dan aras naungan pada pengeluaran bahan kering menunjukkan bahawa hasil bahan kering centro dan stylo nyata lebih besar daripada arachis dan burgundy di bawah 0% teduh, bagaimanapun, centro mencatatkan hasil lebih tinggi daripada semua kekacang pada 50% naungan, trend yang sama diperhatikan di naungan 70%, tetapi perbezaan itu hanya ketara apabila centro telah dibandingkan dengan arachis. Hasil bahan kering rumput dan kekacang menurun dengan peningkatan tahap teduh. Campuran guinea- centro disyorkan berdasarkan hasil bahan kering tinggi centro berbanding kekacang lain terutama pada 50% teduh.

Kajian allelopathy dijalankan menggunakan bioesei makmal dan percubaan pasu untuk menguji sama ada rumput guinea mempunyai kesan alelopati pada kekacang menunjukkan bahawa panjang tumbuhan stylo menurun secara bererti ($P<0.05$) dengan campuran 1% ekstrak daun. Hasil bahan kering dan panjang akar dalam burgundy telah menurun dengan ketara oleh serbuk akar manakala hasil centro dan stylo telah dipertingkatkan dengan serbuk daun. Kesimpulannya, kekacang menegak/memanjat (centro) diperhatikan menjadi yang paling serasi dengan guinea. Ini adalah berdasarkan kepada fakta bahawa dalam kajian 1, campuran guinea-centro menunjukkan kecenderungan ke arah hasil bahan kering tinggi daripada monokultur rumput (guinea). Dalam kajian 2, bagaimanapun, campuran guinea-centro tidak merupakan sebahagian daripada rawatan kerana kekurangan percambahan benih centro. Dalam kajian 3, Centro mempunyai hasil bahan kering yang tinggi sedikit dari Arachis dan burgundy dan mengatasi kekacang lain pada 50% teduh. Centro juga tidak terjejas oleh kesan alelopati rumput guinea sebagaimana yang berlaku dalam kajian 4.

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I certify that a Thesis Examination Committee has met on 16th December 2013 to conduct the final examination of Mohammed Baba on his Doctor of Philosophy thesis entitled "Compatibility of four forage legumes with guinea grass (*Panicum maximum* Jacq.)" 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 Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Siti Aisha Hassan, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Yahya Awang, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Hawa Jaafar, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Jim Bidlack, PhD
Professor
University of Central Oklahoma
United State of America
(External Examiner)

NORITAH OMAR, PhD
Associate Professor Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 17 February 2014

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirements for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

Mohd Ridzwan Abd. Halim, Ph.D.
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Abd. Razak Alimon, Ph.D.
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Abdul Shukor Juraimi, Ph.D.
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

_____
BUJANG BIN KIM HUAT, PhD.
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

Declaration by Graduate Student

I hereby confirm that:

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Name and Matric No: **MOHAMMED BABA (GS26109)**

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision,
- Supervision responsibilities as stated in Rule 41 in Rules 2003 (Revision 2012-2013) were adhered to.

Signature ---------- Signature ----------

MOHD RIDZWAN ABD HALIM, PhD **ABD RAZAK ALIMON, PhD**

(Chairman) (Member)

Signature ----------

ABDUL SHUKOR JURAIMI, PhD

(Member)

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