UNIVERSITI PUTRA MALAYSIA

PHYSIOLOGICAL RESPONSES OF WINGED BEAN [PSOPHOCARPUS TETRAGONOLOBUS (L.) DC.] TO SUPPORT SYSTEMS AND RATOONING

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By

MD. MOTIOR RAHMAN

Thesis Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Agriculture
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DEDICATED TO

THE DEPARTED SOULS OF MY

GRANDFATHER AND GRANDMOTHER

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June 1998

Chairman: **Associate Professor Dr. Wan Mohamad Wan Othman**

Faculty: **Agriculture**

Winged bean is an indeterminate, climbing, perennial legume that needs support to achieve high yields. The major constraint to large scale production of winged bean is the need for trellising which incurred an additional cost of production. After harvesting of young or mature pods plants can be cut and the pollarded root stock produces a ratoon crop. Ratooning, a new technique for seed production of winged bean, can reduce the initial expenditure on support structures. Therefore, these studies on the effects of support systems and ratooning on growth and seed production of winged bean were conducted under humid tropical field conditions to document some experimental evidence. Results from the first experiment revealed that when compared to unsupported control, support height of 1 and 2 m caused a significant increase in leaf area

index (LAI), net photosynthesis, relative growth rate (RGR), nodule activity, solar radiation interception (SRI), pattern of dry matter accumulation and partitioning and consequently the seed yield of winged bean. Plants grown on a support height of 2 m had enhanced leaf growth, pod number and total dry matter yield when compared to those on support height of 1 m and unsupported plants.

In the subsequent experiment, the root stock of the main crop was cut off at 126, 140, 154 and 168 days after germination (DAG) and the ratooned crops maintained for the next two crop cycles (126 days/crop cycle). The results suggested that ratooning of winged bean at 126 or 140 DAG would lower the investment expenditure on support structures and produced the highest cumulative seed yield per unit area per unit time.

In the third experiment, winged bean plants were grown on support heights of 0, 1 and 2 m and ratooned at 133, 154 and 175 DAG. There were three crop growth cycles continued in a unit area over time. Support systems and ratooning had a significant influence in increasing nitrogen fixation, nitrogen accumulation in leaves and N partitioning to pods, LAI, net assimilation rate (NAR), net photosynthesis, SRI and consequently the plants growth patterns and seed yield. Plants grown on 2 m support height and ratooned at 133 DAG recorded the highest cumulative seed yield (6.26 t ha^{-1}), largely associated with increased number of pods per plant and leaf dry matter, leaf N and net photosynthetic efficiency. The lowest cumulative seed yield (1.28 t ha^{-1}) was

obtained from unsupported control plants and ratooned at 175 DAG. The data also indicated that winged bean plants grown on support height of 2 m with appropriate ratooning practice is technologically feasible and economically viable.

Principal component analysis gave a clear direction of each desired variable. Nodule mass (NM), leaf dry matter (LDM) and number of pods per plant (PP) are the most important components of nitrogenase activity (NA), total dry matter and seed yield, respectively.

Based on the above findings it is evident that the indeterminate climbing winged bean grown on a 2 m support height accumulated substantial amounts of dry matter and N compared with those on support height 1 m and unsupported plants. It is concluded that in addition to dry matter accumulation, partitioning of leaf dry matter and leaf N play an important role in vegetative growth and seed yield of winged bean. Seed production of winged bean can be increased by more than 5-fold (6.26 t ha^{-1}) by adopting a 2 m support height and appropriate ratooning practices. The optimum time of ratooning at 133 days after germination under support system of 2 m height maximized seed yield per unit area per year, thereby spreading out the cost of trellising over three crop cycles.

Abstrak tesis yang kemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi Keperluan untukIjazah Doktor Falsafah

RESPON FISIOLOGI KACANG BOTOR [*PSOPHOCARPUS TETRAGONOLOBUS* (L.) DC.] TERHADAP SISTEM SOKONGAN DAN CANTASAN

Oleh

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Jun 1998

Pengerusi: **Profesor Madya Dr. Wan Mohamad Wan Othman**

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Kacang botor adalah tanaman saka "indeterminate", menjalar dan memerlukan sokongan untuk pengeluaran hasil yang tinggi. Masalah utama yang dihadapi untuk pengeluaran kacang botor secara besaran ialah keperluan penyediaan sokongan yang menyebabkan pertambahan kos pengeluaran. Selepas penuaian pod muda atau tua, pokok boleh dipotong dan tunggul pokok akan menghasilkan satu tanaman cantasan (ratoon crop). Cantasan adalah satu teknik baru didalam proses pengeluaran biji kacang botor dan ia dapat mengurangkan kos pembinaan sistem sokongan tersebut. Oleh yang demikian, kajian ini telah dijalankan diladang berkeadaan lembab tropika untuk memungut bukti tentang kesan sistem sokongan dan cantasan terhadap pertumbuhan dan pengeluaran biji kacang botor. Keputusan daripada eksperimen pertama menunjukkan bahawa berbanding dengan kawalan, sokongan setinggi 1 dan 2 m meningkatkan dengan bererti indek keluasan daun (IKD), kadar fotosintisis bersih, kadar pertumbuhan

bandingan (KPB), aktiviti nodul, intersepsi radiasi solar (IRS), corak pengumpulan berat kering, pembahagian bahan kering dan akhirnya hasil biji kacang botor. Tanaman diberi sokongan setinggi 2 m mempunyai peningkatan dalam pertumbuhan daun, bilangan pod dan jumlah berat kering yang lebih tinggi berbanding dengan pokok diberi sokongan 1 m dan tanpa sokongan.

Dalam experimen yang seterusnya, bahagian pangkal pokok asal telah dipotong pada 126, 140, 154 dan 168 hari selepas percambahan (HSP) dan tanaman cantasan diselenggarakan untuk 2 musim berikutnya (126 hari per pusingan tanaman). Keputusan yang diperolehi mencadangkan bahawa proses cantasan kacang botor pada 126 atau 140 HSP dapat mengurangkan kos untuk struktur sokongan dan menghasilkan hasil biji gabungan tertinggi per unit kawasan per unit masa.

Bagi experimen yang ketiga, kacang botor telah ditanam melibatkan sokongan pada ketinggian 0, 1 dan 2 meter dan dicantas pada hari ke-133, 154 dan 175 selepas percambahan. Terdapat tiga pusingan tumbesaran tanaman dalam satu unit kawasan dalam satu jangkamasa. Sistem sokongan dan cantasan memberi kesan yang bererti dalam meningkatkan pengikatkan nitrogen, pengumpulan N dalam daun dan pembahagian nitrogen kepada pod, indeks keluasan daun, kadar assimilasi bersih (KAB), kadar fotosintisis, intersepsi radiasi solar dan akhirnya corak tumbesaran pokok dan hasil biji. Pokok diberi sokongan 2 m tinggi dengan cantasan pada minggu ke-19 selepas percambahan

merekodkan hasil biji gabungan yang tertinggi (6.26 t ha^{-1}), yang berkaitan dengan penambahan bilangan pod per pokok, berat kering daun, kandungan N daun dan keberkesanan proses fotosintisis. Hasil biji kumulatif yang terrendah (1.28 t ha^{-1}) diperolehi daripada tanaman tanpa sokongan yang dicantas pada 175 HSP. Keputusan penyelidikan ini menunjukkan juga tanaman kacang botor yang diberi sokongan 2 m tinggi dengan amalan cantasan yang sesuai adalah teknologi yang mudah dan memberi keuntungan yang lumayan.

Analysis komponen utama memberi hala yang jelas terhadap angkubah yang diingini. Berat nodul (BN), berat kering daun (BKD), bilangan pod per pokok (BPP) adalah komponen yang penting bagi aktiviti nitrogenase (AN), jumlah bahan kering dan hasil biji, tiap-tiap satu.

Berdasarkan hasil kajian diatas, adalah jelas bahawa kacang botor yang ditanam dengan sokongan pada ketinggian 2 m boleh menambahkan lebih banyak bahan kering dan N berbanding dengan pokok diberi sokongan ketinggian 1 m dan tanpa sokongan. Dapat disimpulkan bahawa selain penambahan hasil berat kering, pembahagian bahan kering daun dan kandungan N daun, memain peranan penting dalam tumbesaran vegetatif dan hasil biji kacang botor. Pengeluaran biji kacang botor dapat ditingkatkan lebih 5-kali ganda (6.26 t ha^{-1}) dengan menggunakan sokongan setinggi 2 m dan cantasan yang sesuai. Masa cantasan yang optima pada 133 HSP dengan sokongan 2 m tinggi mengeluarkan hasil