

Enhancement of symbiotic growth and yield of vegetable soybean by co-inoculation with *Azospirillum* and *Bradyrhizobium*

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Introduction

Vegetable soybean is a highly nutritious and highly priced economic crop in Malaysia providing a possible net earning of RM11960 ha⁻¹ in 70 days. Local agronomic studies on vegetable soybean is minimal but reports on grain soybean using saturated soil culture technique have shown that it was possible to raise the grain yield of inoculated soybean from 1.5 to 3.0 t ha⁻¹. In vegetable soybean, the short vegetative growth phase to harvest (70 days), makes it an ideal intercrop between the two rain-fed and irrigated padi seasons. Exploiting its N₂-fixing potential through *Bradyrhizobium* and Plant Growth Promoting Rhizobacteria (PGPR) inoculation would not only reduce the input cost but also raise its value as a cash crop.

Winged bean (*Psophocarpus tetragonolobus* (L.) DC), an important source of protein can improve soil fertility from their N₂ fixing activities. It is an indeterminate climbing perennial legume which requires a support system to achieve higher yields. Trellising and ratooning practices can increase seed yield.

Materials and Methods

Three field (small-plot) studies were conducted in MADA, Kedah (Expt.1) and KADA, Kelantan (Expt.2). The plots were laid out in a Randomized Complete Block design with four treatments and five replicates. The treatments were: **MADA plots:** T1 (No fertilizer -N; no *Bradyrhizobium* inoculation), T2 (No fertilizer -N; Inoculated with *Bradyrhizobium* UPMR48), T3 (No fertilizer -N; Inoculated with *Bradyrhizobium* + TAL 102), T4 (Complete fertilizer +N (100 kg N ha⁻¹); No *Bradyrhizobium* inoculation). **KADA plots:** T1 (as MADA plots), T2 (No fertilizer -N; Inoculated with *Bradyrhizobium* UPMR48 + TAL102), T3 (Complete fertilizer +N (100 kg N ha⁻¹); Inoculated with *Bradyrhizobium* UPMR48 + TAL102), T4 (as MADA plots). Basal fertilizer was applied at rates (kg ha⁻¹) of 25 N: 95 P₂O₅: 95 K₂O by using 54 kg urea ha⁻¹, 206 kg Triple Superphosphate ha⁻¹, and 159 kg Muriate of Potash ha⁻¹. Additional fertilizer N (75 kg N ha⁻¹ = 162 kg urea ha⁻¹) was applied to the complete fertilizer +N treatment. Seeds were planted at 10 cm intervals within rows and 50 cm between rows. *Bradyrhizobium* inoculation was done by mixing the 150 seeds (approx. 50g) inoculated plot with 5g of the respective coir dust inoculum.

Two glasshouse (Expt. 3,4) and one field study (Expt.5) were undertaken at UPM with coinoculation of *Azospirillum* and PGPR on vegetable soybean. There were 13 treatments (glasshouse experiment) as follows: T1 (-N - R), T2 (+N - R), T3 (-N + UPMR48), T4 (-N + TAL102), T5 (-N + UPMR48 + TAL102), T6 (-N + UPMB10), T7 (-N + Sp7), T8 (-N + UPMR48 + UPMB10), T9 (-N + UPMR48 + Sp7), T10 (-N + TAL102 + UPMB10), T11 (-N + TAL102 + Sp7), T12 (-N + UPMR48 + TAL102 + UPMB 10) and T13 (-N + UPMR48 + TAL102 + Sp7). In field experiment five treatments were imposed: (T1: -N-R, T2: +N-R, T3: -N+UPMR48+TAL102, T4: -N+UPMR48+TAL102+Sp7, T5: -N+UPMR48+TAL102+UPMB10).

In winged bean a field experiment was conducted on Serdang sandy loam with pH 6.0-6.5. The experiment was laid out in a randomized complete block design with three support system replicated eight times. The support systems were: i) control plants grown on the ground surface i.e unsupported, ii) plants grown with support height of one meter (wire trellis) and iii) plants grown with support height of two meters (Expt.6).

Results and Discussion

Vegetable soybean: Results showed a significant increase in nodulation, growth of plant top and root, and pod yield for the inoculated treatments. Nodule dry weight were significant higher in plants treated with UPMR 48 than TAL 102; UPMR 48 formed more lateral nodules while TAL 102 encouraged more crown nodules. There was also a significant increase in chlorophyll content of YEL due to the *Bradyrhizobium* inoculation (Expt. land 2). Results (Expt.

3, D₄₂) showed that co-inoculation with PGPR and *Bradyrhizobium* significantly increased total nodule number, fresh and dry weight, root volume and dry weight and nutrient uptake compared to plants treated with single inoculation of *Bradyrhizobium* or PGPR. In Expt 4 (D₇₃), combined inoculation with *B. japonicum* and *Bacillus* sp. (UPMB10) showed significant increase in nodulation, plant-N and P and seed-N concentrations, chlorophyll content, top and root dry weights and seed fresh weight as compared to the control (-N-R). The field experiment (Expt.5) showed increased nodulation, chlorophyll content and plant dry weight with co-inoculation. This study clearly indicated that there was a synergistic effect of co-inoculation with *B.japonicum* and PGPR on plant-N and P concentrations, nodulation, growth and yield of vegetable soybean which ensures its potential as a biofertilizer and bioenhancer.

Winged bean : Results showed that plants grown with 2 m supports produced substantial nodule mass, the highest rate of nitrogen fixation, increased nitrogen accumulation of the plant, and seed yield compared to those grown with 1 m supports and unsupported plants.

Conclusions

Bradyrhizobium inoculation increased nodulation, growth and pod yield of vegetable soybean grown in MADA and KADA padi soils. Co-inoculation with *Bacillus sphaericus* UPMB10 can substantially improve nodulation, nutrient uptake and growth of vegetable soybean, thus its potential as a biofertilizer.

In winged bean, supported plants contributed significantly to higher N₂ fixation and leaf N at the vegetative stage. Seed N was also significantly higher than the unsupported plants.

Benefits from the study

Commercial production of *Bradyrhizobium*, *Azospirillum* and plant growth promoting rhizobacteria as inoculants for vegetable soybean and other tropical food legumes to increase protein-food production namely in the rice bowls of Malaysia.

Patent(s), if applicable:

Nil

Stage of Commercialization, if applicable:

Negotiations with MADA and KADA authorities

Project Publications in Refereed Journals

1. Shamsuddin, Z.H. , and Ang, S.B. 1999. Nodulation, symbiotic, growth and yield of vegetable soybean inoculated with *Photorrhizobium* and *Bradyrhizobium*. *Pakistan J. Biol. Sci.* 2(4):1408-1411.
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Project Publications in Conference Proceedings

1. Shamsuddin Z.H., Lu, M.C., Boon, T.K. and H. Rogayah. (2000). Co-inoculation effects of plant-growth promoting rhizobacteria and bradyrhizobia on growth of vegetable soybean. COSTAM Symposium. Sept. 14-21, 2000, Kota Kinabalu, Malaysia.
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Graduate Research

Name of Graduate	Research Topic	Field of Expertise	Degree Awarded	Graduation Year
M. Motior Rahman	Physiological responses of winged bean (<i>Psophocarpus tetragonolobus</i> (L.) DC) to support systems and rationing.	Agronomy	Ph.D	1998
Zainah bt Jalil	Effects of soil moisture and a mixed culture of photosynthetic rhizobia and bradyrhizobia on reducing sugars and symbiotic growth of soybean (<i>Glycine max</i> L.)	Soil microbiology	M. Agric. Sc	1998

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