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EVALUATION ON FIELD PERFORMANCE OF VEGETABLE SOYBEAN (*Glycine max* (L.) Merrill) VARIETIES GROWN AT TWO LOCATIONS IN MALAYSIA

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ABSTRACT

A study was undertaken to investigate the interaction between varieties and soil environments. The experiments were conducted using randomized complete block design (RCBD) with three replications at two different locations representing two different soil types. The locations were; the mineral soil of International Islamic University Malaysia (IIUM) Glasshouse experimental field and the beach ridges interspersed swales (BRIS) soil of Institute Oceanography and Maritime Studies Research Station (IRS) Kuantan, Pahang. The analysis of variance revealed that location contributed significantly to the variations in the number of pod per plant. While, location had no significant effects on the pod yield, number of seeds per plant and plant height. Significant positive correlation was observed between number of pods and seeds per plant for both locations. Between varieties, variety 1 (AGS190) showed the highest marketable pod yield, number of pods and seeds per plant in both locations. The findings from this study could assist the soybean breeders in varietal development, improvement and selection programme in Malaysia.

Key words: Mineral soil; BRIS soil; vegetable soybean; varieties

INTRODUCTION

Vegetable soybean (*Glycine max* (L.) Merrill) is the most important legume crop in the world. It is globally consumed especially in the Asian diet due to its known health benefits such as high quality protein, iron, zinc, vitamin C, phytoestrogen dietary and fiber (Ponnusha *et al.,* 2011). Vegetable soybeans are those harvested at R6 growth of stage (approximately 80% maturity) at which pods are green and fully formed. Vegetable soybean seeds are larger than grain soybean besides being green, soft and sweet in taste (Shanmugasundaram & Yan, 2004). Because of its great potential to be developed commercially as foods and industrial supplements in Malaysia, efforts are being made to grow vegetable soybean widely. As an initial attempt, the present study was carried out to gain information on the variability and correlation among vegetable soybean varieties for yield and component traits when grown in different soil environments.

Beach ridges interspersed swales or BRIS soil is common in the costal parts of east coast in Peninsular Malaysia. It is chosen as the study site because it is considered as a stressful environment and claimed as worthless for agricultural purposes. This is because more than 90% of its composition is sand, has low water retention, high temperature and low fertility (Nur *et al.,* 2015). The only feasible and profitable crop that has been grown on the BRIS soils over the years was tobacco (Usman *et al*., 2014). However, some improvements can be made to increase the fertility using soil amendments such as compost and manure (Mohd & Engku, 1993). Despite of the unfavourable conditions of the soil, previous study by Nurul *et al* (2015) has shown that vegetable soybeans produced good yields when grown under BRIS soil. Compared to BRIS soil, mineral soil is more fertile and has been used widely for agricultural purposes. Therefore, the ultimate

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aim of this study was to select the best vegetable soybean variety in terms of agronomic performances and quality traits by observing their responses under different soil conditions represented by two locations, in order to introduce a new high value vegetable type into the Malaysian market.

MATERIALS AND METHODS

The plant materials evaluated in the study comprised 15 *Glycine max* (L.) Merrill varieties (V1: AGS190, V2: AGS292, V3: AGS464, V4: AGS346, V5: AGS430, V6: AGS432, V7: AGS440, V8: AGS465, V9: AGS471, V10: AGS461, V11: AGS472, V12: AGS466, V13: AGS469, V14: AGS470 and V15: AGS429) that were developed at The World Vegetable Centre (AVRDC), Taiwan and these varieties were brought into trial for varietal evaluations.

Two experiments were laid out using randomized complete block design (RCBD) with three replications at two locations in Kuantan, Pahang. The locations were International Islamic University Malaysia (IIUM) Glasshouse Complex experimental field (3°50'N 103°17'E) for mineral soil and Institute Oceanography and Maritime Studies Research Station (IRS) (3°38' N 103°23'E) Kuantan, Pahang for BRIS soil. The experiments were conducted from May 2015 until September 2015. The Malaysian Meteorological Department daily data were used as indication of climatical conditions for both experimental sites. Organic manure in the form of dried cow dung at the rate of 30 t/ha was incorporated into the soil. Nitrogen, Phosphorus and Potassium (NPK) blue fertilizer at the rate of 2 t/ha were applied during the crop cycle. Lime at the rate of 2 t/ha was also applied to maintain the required pH level.

Evaluation was done as described by Njoroge *et al* (2015). Varietal characteristics of the varieties were observed including the colour of pod, seed coat, flower and pubescence. The shape of leaflet and seed were also recorded. Data collected on morphological traits were days to flowering, days to emergence, days to harvest and plant height. Meanwhile, number of pods, number of seeds and pod yield were collected for yield component traits.

The morpho-agronomic data was statistically analyzed using IBM SPSS Statistics 20 Software. Data was first checked for the homogeneity of variances before proceeding with Two-ways Analysis of Variance (ANOVA) and Kruskal-Wallis procedure to compare means of varieties for each data per location. Means were compared by the Duncan's Multiple Range Test at the probability of $P<0.05$. Correlation analysis was carried out to determine the relationship between the yield and its components.

RESULTS AND DISCUSSION

The physical characteristics of the vegetable soybeans are summarised in Table 1. Based on the colour of flowers observed at flowering stage, the vegetable soybean varieties were classified into two groups (white and purple). Twelve vegetable soybean varieties were the white flower type and three varieties were the purple flower type. Based on seed coat colour, the varieties were classified into four groups (yellow, light green, brown, and black).

Table 1. Varietal characteristics of 15 *Glycine max* (L.) Merrill varieties

Variety	Color				Shape	
	Flower	Seed coat	Pod	Pubescence	Leaflet	Seed
1 (AGS190)	Purple	Yellow	Green	White	Intermediate	Spherical
2 (AGS192)	Purple	Yellow	Green	White	Intermediate	Spherical
3 (AGS464)	White	Light green	Green	White	Intermediate	Spherical
4 (AGS346)	Purple	Light green	Green	White	Intermediate	Spherical
5 (AGS430)	White	Light green	Green	White	Intermediate	Spherical
6 (AGS432)	White	Light green	Green	White	Intermediate	Spherical
7 (AGS440)	White	Light green	Green	Tawny	Intermediate	Spherical
8 (AGS465)	White	Yellow	Green	White	Intermediate	Spherical
9 (AGS471)	White	Brown	Green	Light tawny	Intermediate	Spherical
10 (AGS461)	White	Brown	Green	Light tawny	Intermediate	Spherical
11 (AGS472)	White	Black	Green	Tawny	Intermediate	Spherical
12 (AGS466)	White	Light green	Green	White	Intermediate	Spherical
13 (AGS469)	White	Brown	Green	Light tawny	Intermediate	Spherical
14 (AGS470)	White	Light green	Green	White	Intermediate	Spherical
15 (AGS429)	White	Light green	Green	White	Intermediate	Spherical

Table 2. Mean sum of squares for the yield and its components of varieties evaluated under mineral and BRIS soils

Source	df	Pods per plant (No.)	Seeds per plant (No.)	Pod yield (t/ha)	Plant height (cm)
Block	2	0.843	1.285	0.036	1.515
Variety (V)	14	11.716*	10.089	10.094	6.479
Location (L)	1	2.807*	0.006	0.120	0.039
V x L	14	7.263	6.208	6.975	11.617*
Error		305.654	318.688	309.307	288.764

* $P<0.05$

The analysis of variance (ANOVA) as shown in Table 2 indicates the effects of location and variety and their interactions on the yield and agronomic traits of 15 vegetable soybean varieties. The results revealed that location and variety had significant effects on the number of pod per plant. However, no significant effects detected for number of seed, plant height and pod yield indicating that variations of these traits of each variety had similar trends in both locations. While, non-parametric Kruskal-Wallis test revealed that significant differences existed for days to flowering, days to harvest and days to emergence for both locations and all 15 vegetable soybean varieties.

Figure 1 (a-g) showed the performance of the vegetable soybean varieties grown under mineral and BRIS soils. Figure 1a showed that pod numbers per plant ranged from 54.42 (V12) – 152.67 (V1) for mineral soil and 16.46 (V9) – 47.13 (V1) for BRIS soil. In Figure 1b, seed numbers per plant ranged from 101.50 (V15) - 325.04 (V1) and 29.29 (V10) - 90.58 (V1) for mineral and BRIS soils, respectively. Pod yield was observed ranging from 3.68 t/ha (V14 & V15) – 9.66 t/ha (V1) for mineral soil and 0.77 t/ha (V9) – 1.79 t/ha (V1) for BRIS soil (Figure 1c). The variety emergences observed ranging from 3.17 (V4) - 4.25 (V7 & V9) days and 3.50 (V10) - 4.79 (V7) days for mineral and BRIS soils, respectively (Figure 1d). In Figure 1e, days to harvest per plant ranged from 58.33 (V2) – 100.13 (V1) and 59.04 (V15) – 67.17 (V1) for mineral and BRIS soils, respectively. The plant heights were recorded to be in the range of 45.67 (V2) – 97.04 (V1) cm for mineral soil and 38.21 (V9) – 61.79 (V4) cm for BRIS soil in Figure 1f. While, the flowering per plant ranged from 29.71 (V5) – 48.33 (V1) days for mineral soil and 27.13 (V3) - 34.13 (V1) days for BRIS soil as shown in Figure 1g.

Soybean yield can be characterised into several components such as seeds numbers per plant, pods numbers per plant, seeds numbers per pod, nodes numbers per plant and pod yield (Kobraei *et al.,* 2011). In case of vegetable soybean, pod yield is one of the major considerations and determinants in variety selection. From the observation, V1 (AGS190) recorded the highest pod yield in both mineral and BRIS soils (9.66 and 1.79 t/ha, respectively). In addition, the pod yield of vegetable soybean varieties tested in mineral soil was also higher than those reported for vegetable soybean at AVRDC, Taiwan (Shanmugasundarm & Yan, 2004). In yield parameters tested, varieties grown under BRIS soil consistently showed lower results compared to mineral soil (Figures 1a-1c). The yield decreases when grown in stress conditions. This is due to the disruption of photosynthesis and remobilization in plants at reproductive growth stage, which can cause the reduction in pod and seed weights (Kobraei *et al.,* 2011).

The results from correlation analysis between yield and yield components are shown in Tables 3 and 4. In general, significant positive correlations were observed between most of the traits. However, negative correlations were also found among certain characters in the present study. Pod yield was positively and significantly associated with number of pods and seeds for both soils. Pod yield also showed a significant positive correlation with plant height and days to flowering for varieties grown under mineral soils. Iqbal *et al* (2003) studied the relationships between characters of 10 soybean varieties and reported that number of pods and seeds showed positive and significant correlations with pod yield. Based on the positive and significant correlations attained by the pod and seed numbers, plant height and days to flowering, selection for high marketable pod yield in vegetable soybean should places maximum emphasis on these four characters. However, for days to harvest and emergence, pod yield was found positive but non-significantly correlated for mineral soil. Meanwhile under BRIS soil, pod yield was positive and non-significantly correlated with plant height, days to emergence, days to flowering and days to harvest.

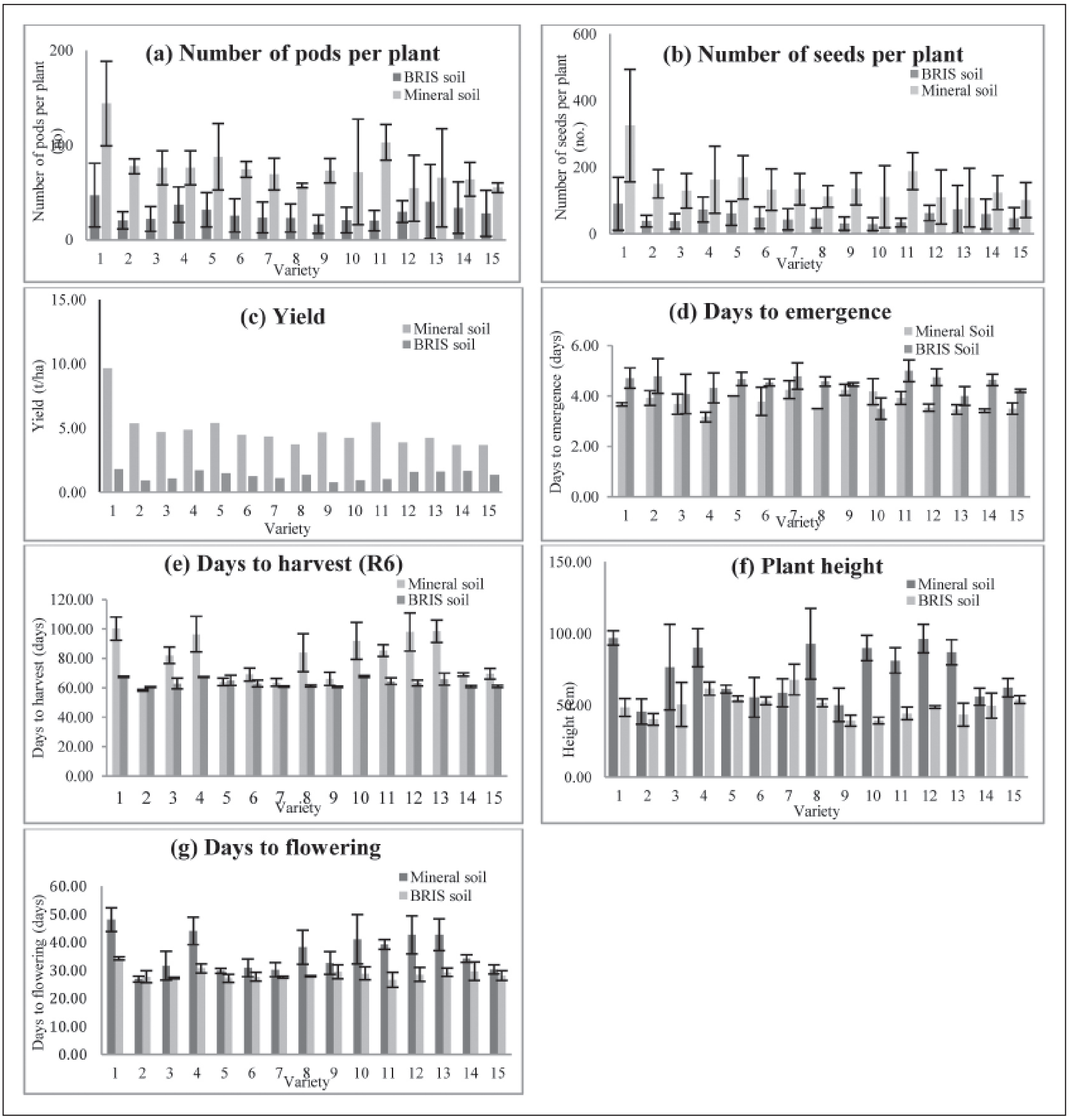

Fig. 1. Varietal differences in agronomic characteristics and yield components of 15 vegetable soybean varieties grown under mineral and BRIS soils.

Table 3. Correlation analysis between yield and agronomic traits for mineral soil

	Pods per plant (No.)	Pod yield (t/ha)	Plant height (cm)	Days to harvest	Days to emergence	Days to flowering
Seeds per plant (No.)	0.978**	0.923**	0.459	0.458	0.188	0.716**
Pods per plant (No.)		0.925**	0.395	0.511	0.024	0.722**
Pod yield (t/ha)			0.590*	0.375	0.090	0.550*
Plant height (cm)				0.091	0.266	0.058
Days to harvest					-0.214	0.557*
Days to emergence						-0.218

* *P*<0.05, ** *P*< 0.01

Table 4. Correlation analysis between yield and agronomic traits for BRIS soil

	Pods per plant (No.)	Pod yield (t/ha)	Plant height (cm)	Days to harvest	Days to emergence	Days to flowering
Seeds per plant (No.)	0.983**	0.977**	0.277	0.259	0.039	0.347
Pods per plant (No.)		0.965**	0.258	0.253	0.090	0.361
Pod yield (t/ha)			0.266	0.262	0.099	0.355
Plant height (cm)				0.862**	-0.364	0.771**
Days to harvest					-0.520*	0.885**
Days to emergence						-0.443

* P<0.05, ** P< 0.0

CONCLUSION

The findings of this study indicate that vegetable soybean varieties showed better performances when grown in a more favourable environment. It also appears from this study that the high yielding variety AGS190 is superior to other varieties in view of its ability to produce higher yield, seed and pod numbers in both locations. Hence, the varietal differences in this study provide information for soybean breeders to select a variety with a better yield performance to be planted under Malaysian soils as well as its climatic conditions. Further study is needed to study on other characteristics involved in variety selection as well such as maturity, disease and pest resistances and lodging in order to select the best *Glycine max* (L.) Merrill variety for an effective and successful crop management plan in Malaysia.

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