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Cultivar Evaluation of Vegetable Soybean on Guam

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Abstract—Vegetable soybean (*Glycine max* (L.) Merrill) accessions developed at the Asian Vegetable Research & Development Center (AVRDC) in Taiwan were evaluated in Guam cobbly clay soil during dry months of 1996 and 2000–01. In 1996 among five accessions, AGS190 (Veroy #4) and AGS335 (Ryokkoh x Mikawashima) were selected for their high yields. During 2000–01, eleven accessions including eight new germlines obtained from AVRDC were grown in order to identify accessions which produced two or more seeded-pods with good seed quality. AGS360 [Neu Ta Pien #2 x (PI 157424 x KS #8)] was our selection. Although its yield was lower than some other accessions, AGS360 had the largest green pods and seeds, which is a desirable trait for marketing. Further field experiments including on-farm trials should be conducted before local selections are released in Guam

Introduction

The vegetable soybean (*Glycine max* (L.) Merrill) is consumed as a popular snack and a vegetable dish in many Asian countries. In Japan, it is consumed mainly as an appetizer with beer (Nakano 1991). Vegetable soybean is one of the main frozen vegetables exported to Japan (Cheng 1991). Unlike grain soybeans, vegetable soybean pods are harvested when the seeds have reached full size and the pods are still green. Vegetable soybean is rich in protein, vitamins A, C and E, and minerals such as calcium and iron (Masuda 1991).

A small but established niche market for vegetable soybeans exists in Guam. In Guam vegetable soybeans are served at many Japanese and Korean restaurants and bars, and some oriental supermarkets sell the frozen vegetable soybeans that have been imported either from Japan or Taiwan (M. Marutani, personal observation). It is hoped that this market will support the development of locally produced vegetable soybeans as an import substitute.

The vegetable soybean project was initiated at the University of Guam in April 1996 with the support of the USDA Western Region Sustainable Agriculture Research and Education, Farmer/Rancher Research Grant to explore the yield potential of crops on the island. After screening accessions on the Agricultural Experiment farm and on-farm trials, selected lines will be released to local community. This paper reports results of initial field screening of vegetable soybean accessions on Guam.

Materials and Methods

A total of 13 vegetable soybean accessions were tested on Guam in 1996 and 2000–01. Parents or the names of pureline of each accession are listed in Table 1. Seeds of all vegetable soybean lines were obtained from the Asian Vegetable Development Center (AVRDC) in Taiwan. In 1996 two trials were conducted to evaluate five accessions, AGS190, AGS292, AGS332, AGS335, and AGS336. The first evaluation was initiated on 12 Apr., 1996, in a farmer's field composed of Guam cobbly clay soil (clayey, gibbsitic, nonacid, isohyperthermic, Lithic Ustorthents) with a pH of around 7.5. It is a typical soil found in the northern part of Guam with very shallow soil laying on limestone beds. The second trial was conducted on the University of Guam campus, having the soil classified as Guam cobbly clay. This trial was started on 21 May, 1996. In both trials, five AVRDC lines were tested in a randomized complete block design (RCB) with four replications. The plot consisted of a 5 m row containing 100 seeds with 1.5 m between two adjacent rows. There were border rows and plants at the ends of a row surrounding the test plots. Data were taken for yield and for horticultural traits of accessions as suggested by the AVRDC Cultivar Evaluation Guide (AVRDC 1996). Plant characteristics studied included the number of days to emergence (when 50% of the plants in a plot germinated), the number of days to flower (when 50% of the plants in a plot produced their first flower), the number of days to harvest, plant height at flowering, plant height at maturity or harvest, the number of nodes on main stem, the number and the weight of 1-seeded and ≥ 2 seeded pods harvested from five plants, and pod yield and plant fresh biomass (leaves + stem) yield per plot. Seed pods were characterized by their length and width. The weight of pod was compared by counting the number of pods in 200 gm. The smaller the number of pods in a given mass, the heavier the pods. The color of pods was also recorded as dark green, green, yellow green or yellow. Seeds were characterized by their fresh and dry weight.

Table 1. Soybean accessions evaluated on Guam. All accessions were obtained from AVRDC in Taiwan.

Acc. No.	Parent or Name of Pureline
AGS190	Vesoy #4
AGS292	Taisho Shiroge
AGS332	Ryokkoh x KS #8
AGS335	Ryokkoh x Mikawashima
AGS336	(SRF 400 x Tsurunoko) x Taisho Shiroge
AGS 346	[Ryokkoh x (Shih SHih x SRF 400)] x Emerald
AGS 358	(Ryokkoh x KS #8) x Taisho Shiroge
AGS 359	(Ryokkoh x KS #8) x Taisho Shiroge
AGS 360	Neu Ta Pien #2 x (PI 157424 x KS #8)
AGS 361	Ryokkoh x F_3[PI157424 x KS #8) x Neu Ta Pien #2]
AGS 362	(Ryokkoh x KS #8) x (Ryokkoh x Mikawashima)
AGS 363	(Ryokkoh x KS #8) x Taisho Shiroge
AGS 364	(Ryokkoh x KS #8) x Vesoy #4

Table 2. Days to flower, days to harvest, % plant stand at harvest, yield, plant height and the number of nodes on main stem of soybean accessions evaluated in Dededo, Guam in 1996. Seeds were sown on 12 Apr 1996.

Accession	Days to flower	Days to harvest	% stand at harvest	Yield (g/plot)			Plant height (cm) at harvest	No. of nodes on main stem
				Total pods	≥ 2 seed pods	Leaves+stems		
AGS190	35	73	62	1606	1192	2258	19.4	10.3
AGS292	25	49	41	896	665	1992	20.0	8.0
AGS332	33	66	29	740	680	1632	27.1	11.9
AGS335	35	62	40	1162	1062	1581	25.1	11.4
AGS336	30	54	64	1081	897	2640	21.6	9.8
Mean	31.4	60.8	47.2	1096.7	899.2	2080.7	22.7	10.3
LSD (0.05)			14.3	745.9	522.5	1052.8	3.6	2.1
CV (%)			15.4	34.6	29.6	25.8	8.1	10.3

Table 3. The number and weights of 1-seed and ≥ 2-seed pods harvested from 5 sample plants, the length and width of 2-seed pod, the number of pods per 200 gm, fresh and dry weight of 100 seeds, % dry matter (DM), and % damaged pods of vegetable soybean accessions evaluated in Dededo, Guam in 1996. Seeds were sown on 12 Apr 1996.

Accession	Pods no./5 plants		Pods wt./5 plants		Size of 2-seed pod		No. of pods	Wt (g) of 100 seeds		% DM	% Damage
	1 seed	≥ 2 seed	1 seed	≥ 2 seed	L(cm)	W(cm)	per 200 gm	Fresh	Dry	Seeds	Pods
AGS190	21.8	103.0	12.3	135.8	5.6	1.4	128	23.3	7.8	33.5	6.0
AGS292	31.3	73.3	23.3	102.8	4.8	1.3	133	26.8	6.2	23.3	12.5
AGS332	22.3	132.0	10.0	159.8	5.2	1.1	200	39.5	12.6	31.9	7.3
AGS335	18.0	95.8	12.8	139.0	6.2	1.4	129	35.0	9.5	27.2	15.5
AGS336	39.8	63.0	28.0	78.8	4.8	1.3	152	30.0	6.6	21.9	4.0
Mean	26.6	93.4	17.3	123.2	5.3	1.3	148.4	30.9	8.5	27.5	9.1
LSD (0.05)	17.6	55.6	17.3	71.6	0.9	0.14	21.5	5.9	2.0	2.3	11.4
CV (%)	33.6	30.3	51.0	29.6	8.3	5.5	7.4	9.7	11.9	4.3	64.3

Table 4. Days to flower, days to harvest, % plant stand at harvest, yield, plant height and the number of nodes on main stem of vegetable soybean accessions evaluated in Mangilao, Guam in 1996. Seeds were sown on 21 May 1996.

Accession	Days to flower	Days to harvest	% stand at harvest	Yield (g/plot)			Plant height (cm) at harvest	No. of nodes on main stem
				Total pods	≥ 2 seed pods	Leaves+stems		
AGS190	37	97	48	3316	3185	2672	42.8	13
AGS292	27	63	52	1590	1448	1220	28.8	9
AGS332	37	90	37	1179	1068	1561	38.8	12
AGS335	37	69	47	1504	1370	1601	42.9	12
AGS336	27	65	45	1235	1078	1492	32.8	10
Mean	33.0	76.8	45.9	1764.9	1629.8	1709.3	37.2	11.3
LSD (0.05)			25.7	1194.7	1135.8	1599.1	11.9	1.7
CV (%)			28.6	34.5	35.5	47.7	16.3	7.7

Table 5. The number and weights of 1-seed and ≥ 2-seed pods harvested from 5 sample plants, the length and width of 2-seed pod, the number of pods per 200 gm, fresh and dry weight of 100 seeds, % dry matter (DM), and % damaged pods of vegetable soybean accessions evaluated in Mangilao, Guam in 1996. Seeds were sown on 21 May 1996.

Accession	Pods no./5 plants		Pods wt./5 plants		Size of 2-seed pod		No. of pods	Wt (g) of 100 seeds		% DM	% Damage
	1 seed	≥ 2 seed	1 seed	≥ 2 seed	L(cm)	W(cm)	per 200 gm	Fresh	Dry	Seeds	Pods
AGS190	15.0	147.7	14.5	240.3	6.0	1.3	76	57.5	21.4	37.1	22.1
AGS292	13.2	80.5	11.5	164.3	7.0	2.2	98	47.5	13.6	28.7	0.0
AGS332	33.0	128.5	23.0	160.8	5.1	1.2	104	59.3	17.6	29.8	2.8
AGS335	15.2	85.3	20.0	178.3	7.1	2.2	82	54.8	15.6	28.5	1.5
AGS336	25.5	82.5	22.5	136.5	5.8	2.0	113	46.5	12.3	26.3	0.5
Mean	20.4	104.9	18.3	176.0	6.2	1.8	94.7	53.1	16.1	30.1	5.4
LSD (0.05)	10.7	93.4	13.5	102.0	0.5	0.3	13.6	10.9	4.4	5.9	
CV (%)	26.8	45.4	37.6	29.5	3.8	8.2	7.3	10.4	14.0	9.9	

Table 6. Days to emergence, % plant stand at flowering, days to flowering, days to harvest, plant height and the number of nodes on main stem of soybean accessions evaluated in the Yigo Experimental Farm on Guam. Seeds were sown on 14 Dec 2000.

Accession	Days to emergence	% stand at flowering	Days to flowering	Days to harvest	Plant height (cm) at flowering	Plant height (cm) at maturity	No. of nodes on main stem
AGS190	6.0	41.7	29.0	63	16.6	20.5	8.0
AGS292	6.0	29.7	25.0	57	20.9	22.2	8.5
AGS335	6.0	11.3	33.0	75	19.5	23.5	9.4
AGS346	5.0	74.0	28.7	76	21.9	25.4	6.8
AGS358	5.0	65.3	28.7	69	23.9	27.8	8.9
AGS359	5.0	70.3	28.7	70	21.3	24.1	8.5
AGS360	6.0	33.7	28.7	71	20.9	23.9	8.4
AGS361	5.7	46.7	28.7	78	20.5	22.4	8.0
AGS362	5.7	42.0	33.0	64	23.6	29.3	10.1
AGS363	5.0	79.3	28.7	81	24.8	29.3	8.3
AGS364	5.0	69.0	28.7	68	22.8	28.1	8.2
Mean	5.5	51.2	29.2	70.2	21.5	25.1	8.5
LSD (0.05)	0.34	15.2	0.44		2.54	2.49	0.82
CV (%)	4.6	21.9	1.1		8.7	7.3	7.2

Table 7. The number and weights of 1-seed and ≥ 2-seed pods harvested from 5 plants, the length and width of 2-seed pod, plant stand % at harvest of soybeans evaluated in the Yigo Experimental Farm on Guam in 2000–01. Seeds were sown on 14 Dec 2000.

Accession	Pods no./5 plants		Pods wt. (g)/5 plants		2-seed pod	2-seed pod	Plant Stand
	1 seed	>2 seeds	1 seed	>2 seeds	Length (cm)	Width (cm)	at harvest (%)
AGS190	9.0	56.7	7.0	90.5	5.0	1.42	41.7
AGS292	9.0	66.7	6.2	112.0	5.1	1.40	29.0
AGS335	25.0	69.0	32.7	147.1	5.3	1.37	11.3
AGS346	6.3	44.3	7.4	94.9	5.1	1.44	72.3
AGS358	3.3	42.3	4.0	90.0	5.0	1.33	65.3
AGS359	2.3	43.7	2.4	73.0	5.0	1.27	70.0
AGS360	9.7	52.7	12.9	135.3	5.4	1.41	33.3
AGS361	5.0	45.0	6.3	99.3	5.1	1.40	44.0
AGS362	13.0	89.3	15.4	181.2	5.1	1.39	42.0
AGS363	4.0	37.7	5.3	81.5	5.1	1.32	79.0
AGS364	4.0	40.0	5.0	73.0	5.2	1.35	65.7
Mean	8.2	53.4	9.5	107.1	5.1	1.40	50.3
LSD (0.05)	5.80	33.96	6.73	71.67	0.33	0.24	14.41
CV (%)	51.9	46.9	52.1	49.9	4.7	12.6	21.1

During 2000–01, eight new accessions (AGS346, AGS358, AGS359, AGS360, AGS361, AGS362, AGS363, and AGS364) were tested during the dry season in the Guam cobbly clay soil at the Yigo Agricultural Experiment Farm. The experiment also included three lines, AGS190, AGS292 and AGS335 which were studied in the 1996 trial. The 2000–01 trial aimed to select the accessions with large two-seeded pods. Seeds were sown on 14 Dec 2000. The same experimental design as the 1996 trial was used and the same phenological data were collected again by following the AVRDC Cultivar Evaluation Guide (AVRDC 1996). Data was analyzed by ANOVA (Abacus Concept, Super Anova 1997) to determine the degree of variation in horticultural traits among accessions.

Results and Discussion

The two 1996 trials showed that AGS 190 (Vesoy #4) and AGS335 (Ryokkoh x Mikawashima) were superior to others in yield (Tables 2 & 4) and had heavier pods (Tables 3 & 5). Pod borer was the most serious pest in the Dededo and Mangilao fields during 1996. *Corynespora* was the major fungal disease occurring in Dededo. Other disease pathogens were isolated but were responsible for only slight damages. Although the soil type was classified as the Guam cobbly clay in all experimental sites, the cropping history, cultural practices, and other environmental factors were different including pest and diseases pressures and other variables that influence plant performance. The results of two field experiments were summarized and presented in the AVRDC tropical vegetable newsletter (Schlub & Marutani 1996).

Table 8. Yields per plot, the number of pods per 200 gm, fresh weight of 100 seeds, and pod color of soybean accessions evaluated in the Yigo Experimental Farm on Guam in 2000–01. Seeds were sown on 14 Dec 2000.

Accession	Yield (g)./plot			Pod No.	Wt. of	
	Total pods	≥ 2 seed pods	Stem+Leaves+ Pods	per 200 g ≥ 2 seeds	100 seeds ≥ 2 seeds	Pod color
AGS190	790	737	1565	123.7	33.1	Green
AGS292	577	480	1122	102.7	35.4	Green
AGS335	414	335	628	89.7	56.3	Green
AGS346	1248	1152	2103	86.3	57.6	Green
AGS358	1128	1055	2062	81.3	59.0	Green
AGS359	1168	1137	2268	110.3	45.2	Yellow-Green
AGS360	825	762	1383	75.3	68.6	Green
AGS361	1087	1007	2060	93.7	58.7	Yellow-Green
AGS362	985	893	2023	89.3	55.4	Yellow-Green
AGS363	1332	1237	2483	94.0	57.1	Yellow-Green
AGS364	1048	987	2289	77.3	58.4	Yellow-Green
Mean	963.8	889.3	1816.9	93.1	53.2	
LSD (0.05)	154.7	142.3	452.0	9.41	4.21	
CV (%)	11.8	11.8	18.3	7.5	5.8	

The results of the 2000–01 trial are summarized in Table 6, 7, and 8. The average days from planting to flowering was 29 days. AGS292 was the earliest maturing line and was harvested in 57 days after planting. Among the advance lines, AGS360 [Neu Ta Pien #2 x (PI 157424 x KS #8)] had very attractive green pods compared to others with yellow-green pods. AGS360 also had large sized pods with 2–3 seeds, which is a desirable characteristic for marketing. In this study, the lower yield of some lines, including AGS360, was due mostly to poor germination at the beginning of the experiment due to improper setting of the irrigation system.

We plan to continue conducting vegetable soybean cultivar trials on agricultural experiment farms and on farmers' fields to further evaluate selected lines in collaboration with AVRDC. The future goal of this project is to release superior lines and to produce seeds locally for distribution.

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