Vegetable Soybean Varietal Improvement at AVRDC

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Introduction

Varietal improvement of vegetable soybean is restricted to a few institutions in China, Japan, Korea, Taiwan and the USA (see related papers in this proceedings). A review of vegetable soybean research at the Asian Vegetable Research and Development Center (AVRDC) since 1985 to 1990 has been presented at the first international vegetable soybean conference held in Kenting, Taiwan in 1991 (Shanmugasundaram et al. 1991). Vegetable soybean research conducted at AVRDC is supported by the Council of Agriculture (COA) of Taiwan. The initial objective was to develop vegetable soybeans acceptable to the Japanese market. AVRDC in cooperation with Kaohsiung District Agricultural Improvement Station (DAIS) succeeded in developing and releasing three vegetable soybean varieties for export to Japan, namely Kaohsiung #1, 2, and 3. In 1990, the total export of Kaohsiung #1 to Japan hit a record of about US$63 million. In this paper, the varietal improvement research conducted at AVRDC since 1991 are presented.

Objectives

The objectives of vegetable soybean varietal improvement activity at AVRDC were: 1) to improve the total pod yield ($\geq$10 t/ha) and graded pod yield ($\geq$ 7 t/ha); 2) to identify and select varieties adapted to tropical and subtropical latitudes; and 3) to improve consumer quality attributes including pod and seed color, appearance, flavor, texture, taste, size of the pod and the number of seeds per pod.

Strategies Used

In the early years, vegetable soybean types from Japan were crossed with grain soybean types adapted to tropics and subtropics. Back crossing was used to recover seed size. Disruptive seasonal selection was used to select for broader adaptation (Shanmugasundaram et al. 1991).

A pureline selection from Taisho Shiroge, AGS 292 was identified as the best and released for farmers in Taiwan by Kaohsiung DAIS as Kaohsiung #1 in 1987. This selection was found to be less sensitive to photoperiod and temperature (Roberts et al. 1996). Therefore, as a first strategy instead of using a grain type soybean, AGS 292 was used as one of the adapted parents to cross with other vegetable type or large seeded soybeans.

Secondly, a search was made to identify soybean germplasm with large seeds. In addition to large seed, other desirable vegetable soybean quality characteristics were also used as selection criteria for use as parents. Some of the parents selected for crosses were: Tanbaguro (large pod

and seed, sweet), Blue Side (dark green pod, large pod, special flavor), Neu Ta Pien 1 and Neu Ta Pien 2 (very large pod and seed), Setuzu and Yukinoshita (fresh green, large pod and seed, sweet).

The third strategy was to understand the genotypic and environmental components of variance for selected traits such as graded pod yield, protein, fat, sugar, color, hardness and seed size. Our results have shown that the genotypic variance (G) for 100 seed weight, protein and fat was higher but for other traits the variance due to seasons (S) and the GxS was higher and significant. The broad sense heritability estimates for sugar content was 0.24 to 0.86 in seven different populations examined. Therefore, it may be possible to select for high sugar genotypes. Pod color is highly influenced by the environment. Selection for pod color, therefore, will be a challenging one.

The fourth strategy was to use the pod length and pod width of two seeded pods to select for large seed size since there was a good correlation between them (Bravo et al. 1980; Frank and Fehr, 1981 and Shanmugasundaram et al. 1991). The broad sense heritability estimates for 100 green bean weights were 0.58 to 0.93.

The fifth strategy was to select for larger proportion of two and three seeded pods. As described in our previous report (Shanmugasundaram et al. 1991) narrow leaflet gene was introduced. Narrow leaflet was associated with a higher number of three- and four-seeded pods (Bernard and Weiss, 1973).

The sixth strategy was to use disruptive seasonal selection for adaptation. At AVRDC, three crops can be grown in a year. February, June and September were the three planting seasons. Specific season adapted types and two and three season adapted types were selected. At AVRDC, results from four-year study suggested that the graded pod yield of February planting was the highest followed by September planting (AVRDC 1995, 1996, 1997 and 19987). The July planting was quite variable due to typhoons and heavy rains.

One hundred bean weights were similar in February and September planting and smaller in July planting. Sugar content was high in September planting and similar in February and July planting. The best entries were included in AVRDC Vegetable Soybean Evaluation Trial (AVSET) for evaluation by cooperators around the world. For those who would like to make their own selections segregating populations from F_2 to F_4 generations were provided.

Both pedigree and single seed descent (SSD) methods were used. At the time of initial yield evaluation sugar, color, protein, fat and hardness were also evaluated. Those lines that were lower in quality traits than the check cultivar, AGS 292 were normally rejected.

In Japan, the genotypes with glabrous or curly pubescent types were reported to be resistant to soybean pod borer, but they were susceptible to potato leaf hopper (Bernard and Weiss, 1973). Since pod borer is one of the problems in vegetable soybean, crosses have been recently made to introduce glabrous gene into vegetable soybean types. Lines D62-7812 (G 2030) and D62-7815 (G 12495) from USA were used as glabrous parents.

In Japan there was emerging interest for a vegetable type soybean with taro flavor. The variety, “Data Cha” has a brown seed coat color and has a taro flavor after blanching. The following Data Chamame varieties are currently used in AVRDC’s breeding: Kocha, Onachugi Data Cha, Shiu-Nai No.2, Wa Sei Data Cha, Sihi-Nai No. 1, Wa Sei Ha-San Data Cha, TS85-21V, and Wuyehedou (black seed coat). It may be interesting to examine their suitability to diversify the palates of the market. At AVRDC we have made crosses to incorporate taro flavor in different seed color and adaptation to the tropics and subtropics.

Since people are becoming health conscious, AVRDC is investigating the variabilities

available in some of the functional nutrients such as tocopherol, isoflavones and antioxidant activities of vegetable soybeans. Efforts will be made to incorporate improved functional nutrients into vegetable soybean. AVRDC's AGS 292 has high isoflavone content (1490 mg/g). Soybean variety Melrose from Australia with high isoflavone content is used to make cross with vegetable soybean. Improved vegetable soybeans with high functional nutrients can be sold as value-added designer grain soybeans.

Germplasm Distribution and Variety Releases

From 1979 until 1990 AVRDC has distributed 712 AVRDC vegetable soybean breeding lines and 670 germplasm to 312 cooperators in 30 countries. From 1991 to 2000, AVRDC has sent 109 AVSETS, 2492 breeding lines and 929 germplasm to 353 cooperators in 57 countries. So far, 10 countries have released 20 different vegetable soybeans for their farmer's cultivation (Table 1).

Table 1. AVRDC vegetable soybean released by cooperators as of 1999.

Local name	AVRDC ID #	Year	Country	Remarks
GC 83005-9	GC 83005-9	1995	Bangladesh	HY, suitable for homestead cultivation
MKS 1	AGS 190	1995	Malaysia	HY
VSS 1	AGS 292	1999	Mauritius	
VSS 2	AGS 339	1999	Mauritius	
Rawal-1	AGS 190	1994	Pakistan	HY
PSB-VS 1	AGS 191	1997	Philippines	HY
PSB-VS 2	AGS 190	1997	Philippines	HY
PSB-VS 3	AGS 186	1997	Philippines	HY
	AGS 190	1992	Sri Lanka	HY, suitable for soymilk and ice cream and soynuts, less beany flavor
Kaohsiung No. 1	AGS 292	1987	Taiwan	HY, MH, DM, EM
Kaohsiung No. 2	Ryokkoh x KS 8	1991	Taiwan	HY, MH
Kaohsiung No. 3	PI 157424 x KS 8	1991	Taiwan	HY, MH
KPS 292	AGS 292	1992	Thailand	HY
CM 1	AGS 190	1995	Thailand	HY, suitable for domestic consumption
Mana	AGS 292	1999	Hawaii, USA	
Makani	AGS 334	1999	Hawaii, USA	
Momona	AGS 337	1999	Hawaii, USA	
Nui	AGS 346	1999	Hawaii, USA	
Buker's Favorite	AGS 292		USA	
VRQ 46	AGS 346	1999	Vietnam	EM (65-85 days), HY (11-14 t/ha), 3 crops/year
Total	20		10	

DM = resistant to downy mildew; EM = early maturing; HY = high yielding; MH = suitable for mechanical harvesting.

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