

Vegetable Soybean In Argentina

BREEDING CULTIVARS ADAPTED TO LOCAL PRODUCTION ENVIRONMENT

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INTRODUCTION

Vegetable soybean, *Glycine max* (L.) Merrill, is very popular in Asia, where it is consumed fresh green. This special soybean is becoming increasingly known in the Western Hemisphere for their nutritious qualities.

Soybean is the main crop in Argentina and occupies a wide ecological area ranging from 23 to 39 degree South latitude. Maturity groups III to IX are used. Argentina is the first soybean meal and soybean oil world exporter. Mostly soybean production is concentrated in the Pampean Region. Although field soybean culture is well known by Argentinean farmers, there is no tradition for vegetable soybean cultivation and consumption in our country.

Vegetable soybean could be an attractive option for Argentinean farmers if local or foreign markets could be developed. A main constrain, however, is the lack of vegetable soybean cultivars (cvs) adapted to local environments. For that reason we started a breeding effort aimed to obtain vegetable soybean cvs adapted to the environmental conditions and cropping systems common in the main soybean producing area of Argentina. Our objectives were to develop a cv. with good agronomic performance, proper pod quality (size) and resistance against prevalent pod and stem diseases. A novel screening technique for pod size selection using volume as single selection criterion was also developed.

MATERIALS AND METHODS

Plant material. Introductions from Taiwan, Brazil and Japan were included in early evaluations. AGS 184; AGS 185 (Houjaku); AGS 186 (Yoshida 1); AGS 187 (PI 85590); AGS 188 (PI 157424); AGS 189 (Disoy); AGS 190 (Vesoy); AGS 191 (BPI 4); KVS 124; GC 84126-13-1-2; GC 84126 13-4-4; GC 84126 13-1-1; GC 84128 9-2-1; GC 84128 11-2-1; and GC 84136 6-4-1-8 genotypes were gently provided by Dr. S. Shanmugasundaram from the Asian Vegetable Research and Development Center, Taiwan. Late Giant, Kanrich, Tomahomare, Suatto, L 81-4590, PI 157440, PI 133226, PI 408251 and PI 86023 genotypes were gently provided by Dr. M.C. Carrao Panizzi from Brazil. Takayama Seeds provided five genotypes from Japan. Sapporo midori and Kitamizusu were also introduced.

Genotypes Characterization. The evaluation of introduced genotypes were carried out in the Experimental Field of the Facultad de Ciencias Agrarias, Univ. Nacional de Rosario, located at Zavalla, Santa Fe, Argentina (33° 01' S). All genotypes were sown in 1993-1994, 1994-1995 and 1995-1996 growing seasons, in five or six sowing dates, ranging from November 8 to December 28. Phenological stages, VE, R1, R6 and R8 were determined according to Fehr and Caviness (1977). Plant height (PH), number of nodes (NN) and branches (NB) were measured on five randomly chosen plants per row. In order to characterize pod parameters ten pods carrying two (2S) or three (3S) seeds were randomly chosen from ten different plants. The length (L), width (W), volume (V) and fresh weight (FW) of 2S and 3S pods were individually determined. Total number of pods per plant (TPN), and the percentage of 2S plus 3S pods (%F) was calculated. Phenotypic correlation among L, W, V and FW, and simple and multiple linear regression were performed. A simple, non destructive method for pod size estimation, using V as a single selection criterion, was developed and used in segregating populations (Benavidez et al., 1999).

Breeding method. Single crosses between selected parents were made in the field during the 1994-1995 growing season. F1 plants were grown in a greenhouse (28 ± 2 °C) under extended 15 h photoperiods from emergence to the 15th day, afterward the plants were shifted to short natural photoperiods (Gosparini & Morandi, 1991). F2 plants grew in greenhouse under natural winter photoperiods in 1995. F3 plants were grown in the field during the 1995-1996 growing season. These F3 plants were classified as early, mid or late maturing and selected by lodging behavior. Selected plants were harvested separately and advanced two generations (F4 and F5) by SSD under greenhouse conditions during the winter, 1996. The F6 was sown in the field, in the summer 1996-1997, and evaluated for stability and agronomic performance. Comparative yield trials of advanced selected lines were conducted during 1997-1998, 1998-1999 and 1999-2000 growing seasons.

Disease evaluation. Pathogens affecting pods and seeds were identified and quantified at R6 and R8 under field conditions. Three pods of 30 randomly chosen plants were disinfected and incubated in Petri dishes. Isolated pathogens were identified by the morphology of their colonies, perithecia, pycnidia and sexual and asexual fructifications. Incidence was expressed as the percent ratio between infected seeds/total seeds (%I) (Pioli et al., 1997). Resistance to soybean stem canker (SSC) was evaluated by artificial infection of seedlings, under greenhouse conditions, with local isolates of *Diaporthe phaseolorum* var. *meridionalis* (Pioli et al., 1999).

RESULTS

Although most introduced genotypes presented desirable pod characteristics, they showed poor fitness to our environmental conditions. The main reasons for the low performance in the field were the length of vegetative and reproductive periods and lodging. Breeding procedures allowed the selection of several lines with good agronomic performance and pod quality. In particular, one of the lines derived from a single cross between GC 84126-13-1-2, from AVRDC (named # 10 in our collection) and an unknown genotype introduced from Japan (named # 47 in our collection) showing outstanding performance in field trials was selected. This line was named

"Agata", and became the first vegetable soybean cv developed in Argentina. The length of different phenophases and lodging scores of Agata and their parents, in normal and late sowing dates, are presented in Table 1. Under our photothermal conditions the cycle of Agata corresponded to maturity group (MG) V. Parent 10 exhibited excessive vegetative growth and high lodging score in our cropping conditions. On the contrary Parent 47 flowers too early and showed reduced vegetative and reproductive growth (Table 1). Agata was intermediate between their parents in cycle length and lodging resistance (Table 1).

Table 1. Days from emergence (E) to: first flower (R1), full seed (R6), and commercial maturity (R8), for the cv. Agata and their parents in normal (Nov. 24) and late (Dec. 22) sowing dates. Field trials were carried out at Zavalla, Santa Fe, Argentina (33° 01' S).

Genotype	November 24				December 22			
	E-R1	E-R6	E-R8	Lodging ¹	E-R1	E-R6	E-R8	Lodging
# 47	43	75	94	2	29	63	85	1
# 10	63	111	146	4.3	40	98	138	3.5
Agata	58	96	120	2.7	39	78	109	2

¹Lodging score: 1 = erect to 5 = prostrate.

Related plant and pod characteristics of Agata and their parents are presented in Table 2.

Table 2. Mean plant height (PH), number of nodes (NN) and branches (NB), total number of pods per plant (TPN), percentage of two plus three seeded pods (%F), and mean length (L), width (W), volume (V) and fresh weight (FW) of pods, for the cv. Agata and their parents.

Genotype	PH cm	NN	NB	TPN	%F	L(cm)	W(cm)	V(cm ³)	FW(g)
# 47	51	11	3	29	73	5.3	1.3	3.2	2.6
# 10	106	23	14	64	87	6.0	1.4	3.0	2.7
Agata	85	19	7	45	81	5.2	1.2	3.2	2.7

Pod appearance is a very important issue in international trading. Appearances include green pod size, pod color, number of seed per pod and seed size. The pod size and the number of seed per pod are genetically determined, so it is important to select for these characters. Screening a segregant population for pod size is time consuming. Usually L and/or W are used. We developed a single procedure to select by pod size using V as a single non-destructive selection parameter (Benavidez and Morandi, 1999). Phenotypic correlation between single pod dimensions (L, W, or V) and FW showed the highest values for V and FW, for both two seeded ($r = 0,72$) and three seeded ($r = 0,74$) pods. In addition, selecting for pod size (FW) at R6 by using V alone yielded the same results than selecting pod size by using L and W jointly (data not shown).

Pathogens affecting carpels and seeds of vegetable soybean at R6 and R8 growth stages are shown in Table 3. At R6, *Alternaria*, *Cercospora*, *Colletotricum* and *Phomopsis* were the main diseases that could affect marketable pod and seed appearance, meanwhile at R8 *Phomopsis* could be a problem by reducing seed quality for the next sowing (Table 3).

During the 1996-1997 growing season an epidemic of soybean steam canker (SSC) occurred in the Pampean Region of Argentina. For this reason, the selection for SSC resistance was also

included in our vegetable soybean breeding program. Early generations segregating plants were inoculated in the greenhouse with several isolates of *Diaporthe phaseolorum* var. *meridionalis* locally collected (Pioli *et al.*, 1999). Agata, as well as both parents, ranked as resistant to all local isolates so far evaluated.

Table 3. Pathogens and percentage of incidence (% I) affecting vegetable soybean carpels and seeds under field conditions, measured at R6 and R8 growth stages.

Pathogen	R6		R 8	
	Carpels	Seeds	Carpels	Seeds
	----- %I -----		----- %I -----	
<i>Alternaria alternata</i>	36.4	41.3	5.5	6.4
<i>Cercospora kikuchii</i>	20.3	14.9	8.6	5.2
<i>Colletotrichum</i>	22.6	27.3	1.0	1.8
<i>Phomopsis</i>	6.6	24.1	0.4	19.7
<i>Penicillium</i>	12.6	1.6	5.0	0.8
<i>Fusarium solani,</i> <i>equisetti & oxysporum</i>	5.3	6.7	1.4	3.7

CONCLUSIONS

Vegetable soybean genotypes introduced from Taiwan, Brazil and Japan could not be used directly under our agroecological conditions but provided enough variability for starting a breeding program.

Pod volume proved effective as an indirect, non destructive, selection criterion for pod size at R6 growth stage.

Breeding work resulted in the development of a new vegetable soybean cv, named Agata, that combines good agronomic performance, pod size, and resistance to SSC caused by *D. Phaseolorum* var. *meridionalis*.

Agata is the first vegetable soybean cultivar fully developed in Argentina and has been presented to fulfill the legal requirements for commercial release.

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