

Vegetable Soybean Development for Export to Japan A Historical and Technical Perspective

Fu-Hsiung Lin, Director General, Kaohsiung District Agricultural Improvement Station, No. 1, Nong-Shih Lane, Min-Shen Road, Ruey-Guan Li, Pingtung 900, Taiwan, ROC. Email: alex3605@ms61.url.com.tw

Shi-Tzao Cheng, Researcher, Kaohsiung District Agricultural Improvement Station, No. 1, Nong-Shih Lane, Min-Shen Road, Ruey-Guan Li, Pingtung 900, Taiwan, ROC. Email: alex3605@ms61.url.com.tw

Introduction

In the 1970s farmers in Kaohsiung-Pingtung area of southern Taiwan began to grow vegetable-type soybean (*Glycine max* L. Merrill) due to its higher profit than grain soybean. Since 1970 Taiwan became the main exporter of frozen vegetable soybean to Japan. The Kaohsiung DAIS began its research to develop new adapted vegetable soybeans to satisfy the needs of local farmers, processors and trading companies. The vegetable soybean varietal improvement research of Kaohsiung DAIS is reviewed in this paper.

Soybean Breeding in Kaohsiung DAIS from 1950-1970

Soybean breeding in Kaohsiung DAIS began in the 1950s. From 1956 to 1970 several soybean cultivars introduced from Japan were extended to local farmers. The most popular variety was Jikkoku (called Shih-Shih in Taiwan). It is early maturing with stable yield and acceptable quality. Between 1971 and 1980, Kaohsiung DAIS cooperated with AVRDC and developed grain soybean varieties, Kaohsiung 3, 8, 9 and 10.

Varietal Improvement for Vegetable Soybean from 1970 to 1980

Customarily the vegetable soybeans in Taiwan are shelled from the pod (Shanmugasundaram et al 1989) and are marketed as fresh beans for use with other vegetables. Shih-Shih introduced from Japan in 1954 is a multipurpose variety and extended to farmers in 1957. It was the most successful variety used as grain as well as vegetable soybean in Taiwan (Shanmugasundaram 1979).

From 1968 to 1970, Taiwan introduced more than 10 vegetable soybean varieties from Japan. After evaluation by Kaohsiung DAIS and local farmers, one variety, "Mikawajima" performed better than other introductions (Chen 1994) and it was the first frozen vegetable soybean variety exported to Japan from Taiwan.

In 1971 to 1972 the variety Tzurunoko (referred to as 205) and a few years later, another variety Ryokkoh (referred to as 305) were introduced. Both varieties were well accepted by farmers, frozen food companies and traders (Shanmugasundaram et al 1991, Chen 1994). With the above two varieties, area planted to vegetable soybean increased, due to its higher profit, than grain soybean.

Varietal Improvement After 1980

Kaohsiung DAIS made pureline selections from Tzurunoko (205), Ryokkoh (305) and Yukinoshita in early 1980s. However, their performances were not better than the parents.

From 1980 to 1983 AVRDC introduced 51 vegetable soybean varieties from Japan. A pureline, AGS 292 selected from Taisho Shiroge at AVRDC was sent to Kaohsiung DAIS for evaluation in regional yield trials. It was recognized as the best selection. The pod and seed quality of AGS 292 was acceptable to the processor and the Japanese consumers. It was registered in 1987 as Kaohsiung No.1 and was the first officially released vegetable soybean in Taiwan (Shanmugasundaram 1990, Cheng 1991). Kaohsiung No. 1 replaced Tzurunoko and Ryokkoh and soon it occupied 90 percent of the total vegetable soybean area in Taiwan.

AVRDC continued to provide a number of F1 seeds from crosses made at AVRDC. Selections in segregating generations and yield trials were conducted by Kaohsiung DAIS. Based on the yield data from different locations and seasons and the quality evaluation, two strains KVS 39 and KVS124 were named as Kaohsiung No. 2 and Kaohsiung No. 3, respectively. The cold tolerant characteristic of Kaohsiung No. 2 enabled it as a leading fresh pod variety exported to Japan at present in Taiwan. (Chen 1994)

From 1988 onwards Kaohsiung DAIS began its hybridization program. Every year 7 to 9 cross combinations were made. In 1996 a pureline selection from Ryokkoh was released as Kaohsiung No. 5. The area planted to Kaohsiung No. 5 at present is about 75 percent of the total vegetable soybean area in Taiwan. (Cheng 1999).

Breeding Vegetable Soybean for Fresh Market

Recently the fresh vegetable soybean export to Japan increased to about 6000 t per year. Farmers and producers urgently need a variety that can be grown during the winter season so that the fresh vegetable soybean pod can be exported to Japan in March, April, and sometimes in May.

To develop such a variety, Kaohsiung DAIS tested F₄ progenies from 11 cross combinations in early December from 1992 to 1993. A total of 770 superior individuals were selected based on their performance in winter season. Twelve promising lines were included in advanced yield trial from 1997 to 1998. The best line, KWVS 13 from cross Ryokkoh 74/KVS 124// Ryokkoh 74 was selected and tested in three locations in Pingtung, southern Taiwan with check variety Kaohsiung No. 2. KWVS 13 showed better yield, larger pods and longer flowering period than check variety Kaohsiung No. 2 (Table 1). We propose to register KWVS 13 in early 2002.

Table 1. Major agronomic traits and yield of KWVS 13 and check variety KS 2 in winter season.

| Variety | Days to maturity (day) | Graded pod yield (kg/ha) | Total pod yield (kg/ha) | Percent of shelling (%) | No. of accept pods/500g |
|---------|------------------------|--------------------------|-------------------------|-------------------------|-------------------------|
| KWVS 13 | 88 | 4213 | 7100 | 80.3 | 121 |
| KS 2 | 85 | 3381 | 5537 | 77.3 | 136 |

Breeding Vegetable Soybean for Fall and Spring

In Kao-Ping area, traditionally vegetable soybean is a fall season crop. However, due to government's 6-year paddy field conversion program, vegetable soybean was also included for spring season. The fall and spring crop environments are different. The studies showed that 46% of the variation in graded pod yield was due to GXE interaction. Therefore, it may be necessary to select specific genotypes for seasons (Shanmugasundaram 1991). Since early 1990s, the vegetable soybean area in southwestern plain of Taiwan and Changwa, central Taiwan increased steadily (Table 2).

Since 1991 Kaohsiung DAIS used disruptive seasonal selection for high yield, high quality large seed size and bright green pod color. The superior lines were advanced to regional yield trial in Tainan and Kaohsiung districts. Two elite lines KVS 844 and KVS 862 were selected for high quality and satisfactory yield. Both lines are proposed to be released in early 2002. The major traits of these two lines are compared with check varieties Kaohsiung No. 1, No. 2 and No. 5 in Table 3.

Table 2. Vegetable soybean area and production in different districts of Taiwan.

| Year | District | | | | | |
|------|------------------------|--------------------|----------------------------|--------------------|-------------------------------|--------------------|
| | Kao-Ping ^{1/} | | Yun-Chia-Nan ^{2/} | | Chung-Chang-Tou ^{3/} | |
| | Acreage (ha) | Production (mt) | Acreage (ha) | Production (mt) | Acreage (ha) | Production (mt) |
| 1990 | 8816 | 48876 | 152 | 1475 | 638 | 4030 |
| 1991 | 9160 | 51075 | 315 | 2404 | 953 | 5728 |
| 1992 | 9804 | 57024 | 334 | 2550 | 820 | 8420 |
| 1993 | 8323 | 54002 | 534 | 4675 | 1755 | 18680 |
| 1994 | 8298 | 57997 | 992 | 8275 | 1124 | 12908 |
| 1995 | 5567 | 37856 | 1337 | 12349 | 1319 | 15878 |
| 1996 | 5058 | 34273 | 2695 | 23852 | 1461 | 16233 |
| 1997 | 4261 | 29260 | 3381 | 28247 | 993 | 7116 |
| 1998 | 4391 | 30693 | 4550 | 39201 | 1125 | 12899 |
| 1999 | 2502 | 16416 | 4143 | 34592 | 1017 | 9864 |

^{1/}Kao-Ping = The most southern part of Taiwan

^{2/}Yun-Chia-Nan = West and southern plain of Taiwan

^{3/}Chung-Chang-Tou = Central part of Taiwan

Table 3. A comparison of new vegetable soybean lines with popular varieties.

| Entry | Days to harvest | Graded Pod yield (t/ha) | Protein (%) | Sugar (%) | Panel test score | |
|---------|--------------------|-------------------------------|----------------|--------------|------------------------------|--------------------------------|
| | | | | | Taiwan processor (n = 13) | Japanese processor (n = 21) |
| KVS 844 | 70 | 6.4 | 39.5 | 14.7 | 2.87 | 3.60 |
| KVS 862 | 70 | 5.3 | 46.6 | 13.3 | 2.83 | 3.50 |
| KS 1 | 65 | 6.9 | 40.0 | 13.3 | 2.73 | 2.93 |
| KS 2 | 74 | 6.2 | 42.9 | 13.9 | 2.73 | 3.00 |
| KS 5 | 70 | 6.6 | 42.5 | 13.7 | 2.82 | 3.43 |

Panel test score: The highest is 4. The lowest is 1. Score is averaged from shape, color, size, hardness, sweetness and flavor of pod.

Future Direction

The high production cost caused by high labor wages and small scale farm management pose considerable pressure to the vegetable soybean industry in Taiwan. The government imported the harvester from FMC, France in 1993. Its high efficiency reduced the production cost by 25%

Taiwan has to compete with the vegetable soybean from mainland China, Thailand and Indonesia. The lower production cost and improving production and processing techniques of these countries is a challenge to Taiwan. The estimated market share of Taiwan's export to Japan reduced from 90 percent to 50 percent in 1999. The difference in price between Taiwan and the above countries is also narrowing. (Cheng, 1999)

Development of varieties with different taste is increasing in importance. In addition to

traditional large pod and seed variety, the aromatic variety or the products from organic farming practice also have a place in the market.

The government and association of frozen vegetable exporters are making efforts recently to promote and expand domestic consumption of vegetable soybean.

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