

Growth Characteristics and Seed Yield of Medicinal Soybeans Collected in Korea

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ABSTRACT

Seeds of medicinal soybean [*Glycine max*(L.) Merrill] are characterized by a black seed coat, white stripe at hilum border, yellow cotyledon, and very small seed weight. Production of this medicinal soybean has recently increased as a consumption increased. The objective of this study was to evaluate the growth characteristics and seed yield of collected medicinal soybeans and to obtain basic information on production practices and breeding materials. The collected medicinal soybean lines were cultivated at three locations for two years. Twenty-seven lines were planted at the Research Farm, Korea University, Namyangju city, on May 23, and at the Research Farm, Kyungpook National University, Taegu, on May 20, 1995. In 1996 field experiments, forty-four lines were planted on May 25, at Research Farm, Korea University, and twenty-seven lines among those were planted on June 7 at the Research Farm of National Yeongnam Agricultural Experiment Station, Milyang city. The investigated lines had purple or white flower. Flowering and maturing dates were similar or later than those of the control cultivars. Branch number was greater for the investigated lines. One hundred-seed weight of the lines ranged from 8.5 to 15.0 g. Mean seed yields ranged from 1.54 to 2.89 MT/ha. Nine lines of the investigated medicinal soybeans showed higher yield capacity than the control cultivars. Further research should be done on the improvement of the production system and breeding program of medicinal soybeans.

Key word : *Glycine max*, medicinal soybean, flowering time, maturing time, one hundred-seed weight, seed yield.

Soybeans [*Glycine max*(L.) Merrill] originated in northeastern Asia and are widely distributed from the upper end of the temperate region to tropical areas. This wide adaptability of soybeans is due to the diversity of the genetic resources. Soybean cultivars are sensitive to environmental factors such as day length, temperature, water, and other cultural conditions and could be categorized in several ways. The classifications of soybean cultivars could be made according to usages, seed size, seed coat color, hilum color, stem habit, maturity, and determinate or indeterminate type (Cho, 1986). Soybean seeds are used in general for Doenjang (or soy paste), tofu, soymilk, cooking with rice, soybean oil, soybean

sprout, and animal feed. Soybean cultivars which were used traditionally for medicinal purpose in Korea can be defined as medicinal soybeans.

The seed used for medicinal purpose have some common characteristics including a black seed coat, white stripe at the hilum border, and very small seed weight with yellow cotyledon, and called 'Gyoonikong' ('Seomoktae') or 'Yakkong' (medicinal soybeans). These medicinal soybeans were originally named 'Yeodoo' or 'Heugsodoo' by Lee (1592), 'Yeodoo' or 'Wungheugdoo' by Hur (1613), and 'Yeodoo' ('Gyoonikong'), small black soybean or 'Wungheugdoo' by Hwang (1885). Chang (1988) has reported 'Yeodoo' or 'Gykong' ('Seomoktae') from ancient agricultural books.

These soybean seeds have been reported to have a common remedy effect on human diseases known as detoxification, even though the exact chemical component have not been proven yet (Chang, 1993; Chung & Shin, 1990; Lee, 1994). However many researchers have suggested that the chemical components in soybean seed, which have medicinal effects, may be saponins (Kim et al., 1994; Oakenfull, 1981; Proce et al., 1987), isoflavones (Holt, 1997; Kim, 1996; Kim et al., 1996; Molteni et al., 1995), and oligosaccharides (Choi et al., 1995). Recently the consumption of these medicinal soybeans is increasing very rapidly for a remedy against poison or for a functional food probably due to the increasing pollution of air and water and foodstuff poisoning.

Local black soybeans in Korea were collected and tested for agronomic traits (Kim et al., 1993a), seed characteristics (Kim et al., 1993b; Kim et al., 1993), and maturity group (Kim et al., 1997). Some of these tested lines could be categorized as medicinal soybeans. The objective of this study was to evaluate the growth characteristics and seed yield of local medicinal soybeans which were collected nation-wide in Korea and to obtain the basic information on production practices and breeding materials.

MATERIALS AND METHODS

Collection and selection of medicinal soybeans

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Table 1. Selection number, collected line name, and seed characteristics of Korean medicinal soybeans.

| Selection number | Collected line name | Flower color [†] | Seed coat [‡] color | Hilum color [‡] | Seed coat texture | 100-seed weight |
|------------------|---------------------|---------------------------|------------------------------|--------------------------|-------------------|-----------------|
| | | | | | | —g— |
| KU1 | Kapyong 1-1 | P | B | B | shiny | 11.0 |
| KU2 | Kapyong 2-1 | P | B | B | medium | 11.5 |
| KU3 | Kapyong 2-2 | W | B | B | coarse | 8.8 |
| KU4 | Kangwon 1-1 | P | B | B | very shiny | 10.6 |
| KU5 | Kangwon 1-2 | W | B | B | very shiny | 11.2 |
| KU6 | Kangwon 1-1-1 | W | B | B | shiny | 10.0 |
| KU7 | Kangwon 2-1 | P | B | B | shiny | 10.7 |
| KU8 | Kangwon 2-3 | P | B | B | shiny | 9.3 |
| KU9 | Kangwon 3-1 | P | B | B | shiny | 11.0 |
| KU10 | Kangwon 3-2 | W | B | B | shiny | 11.4 |
| KU11 | Kangwon 4-1 | P | B | B | shiny | 9.2 |
| KU12 | Kangwon 4-3 | W | B | B | very shiny | 10.6 |
| KU13 | Kangwon 5-1 | P | B | B | very shiny | 9.6 |
| KU14 | Kangwon 5-2 | P | B | B | coarse | 10.6 |
| KU15 | Kangwon 5-3 | W | B | B | very shiny | 11.3 |
| KU16 | Kangwon 6 | P | B | B | shiny | 10.1 |
| KU17 | Kangwon 7-1 | P | B | B | medium | 11.6 |
| KU18 | Kangwon 7-2 | W | B | B | shiny | 11.3 |
| KU19 | Kangwon 8-1 | P | B | B | shiny | 13.2 |
| KU20 | Kyonggi 2 | P | B | B | shiny | 13.2 |
| KU21 | Kyonggi 2-1-1 | P | B | B | shiny | 12.0 |
| KU22 | Kyonggi 2-1-2 | W | B | B | medium | 12.0 |
| KU23 | Kyongnam 2 | P | B | B | shiny | 11.6 |
| KU24 | Kyongsan 1 | P | B | B | shiny | 11.3 |
| KU25 | Kurye 1-2 | W | B | B | shiny | 11.6 |
| KU26 | Kurye 2-1 | P | B | B | shiny | 10.9 |
| KU27 | Kurye 2-2 | W | B | B | shiny | 11.7 |
| KU28 | Puan 1-2 | W | B | B | shiny | 11.2 |
| KU29 | Yangpyong 1 | P | B | B | medium | 10.8 |
| KU30 | Yangpyong 3 | W | B | B | shiny | 11.1 |
| KU31 | Yongchon 1-1 | P | B | B | very shiny | 10.5 |
| KU32 | Yongchon 1-2 | W | B | B | shiny | 12.0 |
| KU33 | Yongchon 2-2 | W | B | B | shiny | 11.7 |
| KU34 | Wonju 1 | P | B | B | shiny | 9.6 |
| KU35 | Jeonla | P | B | B | shiny | 9.9 |
| KU36 | Chongyang | P | B | B | shiny | 9.0 |
| KU37 | Chungnam 1-1 | P | B | B | shiny | 10.5 |
| KU38 | Hadong 1-2 | W | B | B | shiny | 11.7 |
| KU39 | Hadong 2-1 | P | B | B | very shiny | 10.7 |
| KU40 | Hongsong 1 | P | B | B | coarse | 14.7 |
| KU41 | Hongchon | P | B | B | shiny | 12.3 |
| KU42 | Kangwon 4-1-1 | P | B | B | shiny | 9.6 |
| KU43 | Puan 2 | P | B | B | very shiny | 13.2 |
| KU44 | Yungdong 2 | W | B | B | shiny | 11.4 |
| KU45 | Kangwon 1-2-1 | P | B | B | shiny | 12.0 |
| KU46 | Kangwon 2-3-1 | W | B | B | shiny | 11.2 |

[†] W: White, P: Purple, [‡] B: Black.

Medicinal soybean seeds [*Glycine max*(L.) Merrill] were collected at the market place of oriental medicine in Seoul, Taegu, Kwangju, Taejon, and other local areas from 1991 to 1995. Field experiments for seed production and selection were conducted at the Research Farm of College of Natural Resources, Korea University, located at Namyangju city, Kyonggi province from 1992 to 1996. Selected lines of these medicinal soybeans were evaluated for seed yield and composition characteristics in the areas of Namyangju, Taegu, and Milyang from 1994 to 1996. These selected and evaluated lines of medicinal soybeans were registered at the Gene Bank, Genetic Resources Division, National Agricultural Science and Technology Institute, and were recommended for further research by the Upland Crops Division, National Crop Experiment Station, RDA as listed in Table 1.

1995 Experiments

Field experiments were conducted both at the Research Farm of College of Natural Resources, Korea University and at the Research Farm of College of Agriculture, Kyungpook National University in Taegu for the evaluation of genetic characteristics and productivity of the collected medicinal soybean along lines. Twenty-seven lines, medicinal soybeans were planted along with the controls, 'Hwangkeumkong' and 'Geomjeongkong' 1 or 'Williams 79'. Planting date was May 23 at Namyangju and May 20 at Taegu, and planting density was 60×15 cm with two seeds in silt-loam soil at both places. Plot size for each line was two rows 2.3 m and 3 m long with two rows at Namyangju and Taegu, respectively. Sprinkler irrigation was applied from planting to R6 stage whenever needed.

Randomized complete block design was used with three replications in both areas. Other cultural practices were followed with the standard cultural methods. Growth characteristics and yield components were measured with growth stage increment and at full maturity. Statistical data analysis was performed with the SAS PC package.

1996 Experiments

Field experiments were conducted at the Research Farm of College of Natural Resources, Korea University. Forty-four medicinal soybean along lines with the controls, Hwangkeumkong and Geomjeongkong 1, were tested in this experiment. The soil of the experimental site was siltloam. Planting date was May 25 and planting density was 60×15 cm with two seeds. Plot size was 1.8 m long with three rows. Sprinkler irrigation was applied from planting to R6 stage whenever needed.

Twenty-seven lines tested in 1995 were further evaluated along with the two control cultivars, 'Mallikong' and Geomjeongkong 1, were tested at the Research Farm of National Yeongnam Agricultural Experiment Station. The experimental site had silt-loam soil. Planting date was June 17 and planting density was 60×10 cm with two seeds. Plot size was 2 m long with three rows.

Randomized complete block design was used with three replications in both areas. Other cultural practices were followed with standard cultural methods. Growth characteristics and yield components were measured with growth stage improvement and at full maturity. Statistical data analysis was performed with the SAS PC package.

RESULTS AND DISCUSSION

1995 Experiments

Seed yield and growth characteristics of collected medicinal soybean lines tested in Namyangju area are shown in Table 2. Flower colors of twenty-seven collected medicinal soybean lines were purple or white. Flowering dates ranged from July 24 to August 6 compared to July 24 of the control cultivar Hwangkeumkong. Maturing time of the lines was from September 29 to October 13 and that of control cultivar was September 30. These results indicated that flowering and maturing times of the collected medicinal soybean lines are generally later than that of the recommended cultivar. Plant heights of the lines ranged from 43 to 73 cm compared to 61 cm of the control cultivar. Branch number of the lines ranged from 8.3 to 13.7 and that of the control cultivar was 8.7, indicating that the collected medicinal soybean lines had more branches. One hundred-seed weights of the lines were distributed from 8.5 to 12.4 g as compared to that of the control cultivar of 28.9 g. Kim et al. (1993b) have also reported this range of one hundred-seed weights from collected black soybean lines. One of seed characteristics of medicinal soybeans is the very small seed. Seed yields of the tested lines were distributed a wide range of the minimum of 1.88 to maximum of 4.38 MT/ha and seed yield of the control cultivar was 2.33 MT/ha. Seventeen lines of medicinal soybeans tested in this experiment showed higher seed yield than that of the control cultivar, and that meant the potential of high productivities of medicinal soybean lines.

In Taegu experiments (Table 3), flowering dates of twenty-seven medicinal soybean lines ranged from July 15 to July 25 compared to July 17 of the control cultivar Hwangkeumkong. Maturing dates of the lines were distributed from October 17 to October 25 compared to October 21 of the control cultivar. Flowering dates of the lines were later but maturing dates were earlier or later than the control cultivar. Shorter or taller plant heights were found in the tested lines as compared to the control cultivar. Branch numbers of the lines ranged from 4.4 to 9.4 and the control cultivar had 3.6 branches, indicating that collected medicinal soybean lines produce more branches than the control cultivar. One hundred-seed weights of the lines were distributed with the range of 10.2 to 15.0 g compared to 18.8 g of the control cultivar. Seed weights of the lines in Taegu experiments were heavier than those of the lines in Namyangju experiments. However, lower seed yields of the lines were found in Taegu experiment. These results were probably

Table 2. Growth characteristics and seed yield of collected medicinal soybean cultivated in Namyangju in 1995[†].

| Collected line name | Flower color | Flowering date | Maturing date | Plant height | Branch number | 100-seed weight | Seed yield |
|---------------------|--------------|-----------------|---------------|--------------|---------------|-----------------|------------|
| | | — Mon. · Date — | | — cm — | — no. — | — g — | — MT/ha — |
| Kapyong 1-1 | P | Aug. 3 | Oct. 13 | 60 | 9.7 | 10.5 | 4.38 |
| Kapyong 2-2 | W | Aug. 3 | Oct. 13 | 65 | 11.0 | 8.9 | 3.15 |
| Kangwon 1-1 | P | Aug. 1 | Oct. 13 | 65 | 10.7 | 10.1 | 3.25 |
| Kangwon 1-1-1 | W | Aug. 1 | Oct. 13 | 48 | 10.7 | 9.7 | 2.21 |
| Kangwon 2-1 | P | Aug. 3 | Oct. 13 | 57 | 11.7 | 9.6 | 3.53 |
| Kangwon 3-1 | P | Jul. 28 | Sep. 29 | 52 | 7.0 | 11.3 | 2.71 |
| Kangwon 4-1 | P | Jul. 31 | Oct. 13 | 63 | 8.7 | 10.0 | 3.50 |
| Kangwon 5-1 | P | Aug. 1 | Oct. 13 | 47 | 10.3 | 8.9 | 1.88 |
| Kangwon 6 | P | Aug. 1 | Sep. 29 | 43 | 9.7 | 9.0 | 2.26 |
| Kangwon 7-2 | W | Aug. 4 | Oct. 13 | 58 | 10.0 | 11.6 | 3.98 |
| Kangwon 8-1 | P | Aug. 1 | Oct. 13 | 77 | 11.7 | 12.4 | 3.31 |
| Kyonggi 2 | P | Jul. 24 | Sep. 29 | 60 | 8.7 | 11.0 | 2.32 |
| Kyongnam 2 | P | Aug. 4 | Oct. 13 | 73 | 8.3 | 11.6 | 4.27 |
| Kyongsan 1 | P | Aug. 1 | Oct. 13 | 73 | 10.0 | 11.5 | 3.54 |
| Kurye 1-2 | W | Aug. 2 | Oct. 13 | 53 | 10.0 | 10.1 | 2.86 |
| Kurye 2-1 | P | Aug. 1 | Oct. 13 | 67 | 12.0 | 12.0 | 3.24 |
| Yangpyong 1 | P | Aug. 1 | Oct. 13 | 70 | 10.3 | 11.8 | 3.28 |
| Yongchon 1-1 | P | Aug. 3 | Oct. 13 | 67 | 11.7 | 12.0 | 3.51 |
| Yongchon 2-2 | W | Aug. 1 | Oct. 13 | 73 | 10.3 | 10.1 | 3.61 |
| Wonju 1 | P | Aug. 1 | Oct. 13 | 53 | 11.0 | 9.5 | 3.97 |
| Jeonla | P | Jul. 31 | Oct. 13 | 57 | 10.7 | 9.6 | 2.87 |
| Chongyang | P | Aug. 6 | Oct. 13 | 67 | 13.7 | 8.5 | 3.37 |
| Chungnam 1-1 | P | Jul. 28 | Sep. 30 | 50 | 9.3 | 9.4 | 2.68 |
| Hadong 1-2 | W | Aug. 1 | Oct. 13 | 60 | 11.0 | 10.8 | 2.74 |
| Hadong 2-1 | P | Aug. 3 | Oct. 13 | 68 | 9.0 | 10.6 | 3.08 |
| Hongsong 1 | P | Aug. 1 | Oct. 13 | 63 | 10.3 | 10.3 | 2.97 |
| Hongchon | P | Aug. 1 | Oct. 13 | 67 | 9.3 | 11.3 | 3.99 |
| Hwangkeumkong | P | Jul. 24 | Sep. 30 | 60 | 8.7 | 28.9 | 2.33 |
| Geomjeongkong 1 | W | Jul. 24 | Sep. 30 | 62 | 8.7 | 29.4 | 3.00 |
| LSD _{0.05} | — | — | — | 6 | 1.5 | 1.4 | 0.21 |

[†] Planting date: May 23, 1995.

due to the drought stress during flowering periods, which induced decreased pod numbers causing lower seed yield and increased seed weight. Seed yields of the lines ranged from 0.31 to 2.96 MT/ha and seed yield of the control cultivar was only 0.92 MT/ha. Eighteen lines of collected medicinal soybeans showed higher yielding capacity than did the control cultivar Hwangkeumkong. In summary, all agronomic characteristics investigated in this experiment showed the same trends in both areas.

1996 Experiments

Growth characteristics and seed yield of forty-four collected lines of medicinal soybeans cultivated in Namyangju area are shown in Table 4. Flowering dates of the lines ranged from July 19 to August 6 and flowering date of the control cultivar Geomjeongkong 1 was July 22. Maturing dates of the lines ranged from September 25 to

October 15 compared to October 8 of the control cultivar. From the results of 1995 experiments, flowering and maturing dates of twenty-seven lines planted in both years were shown to have the same trends. Shorter or taller plant heights of the lines were also found when compared to that of the control cultivar. Branch numbers of the lines ranged from 6.0 to 12.0 in contrast to 5.3 of the control. Similar results were observed for branch numbers in both years. One hundred-seed weights of the lines ranged from 8.8 to 13.2 g as compared to 34.7 g of the control cultivar, indicating the same trends with 1995 experiments. Seed yields of the lines ranged from 1.58 to 4.43 MT/ha and seed yield of the control cultivar was 3.07 MT/ha. Fifteen lines of medicinal soybeans showed higher yields than did the control cultivar. In Namyangju area, the results of both years were found to have the same trends on growth characteristics and seed yields.

Table 3. Growth characteristics and seed yield of collected medicinal soybeans cultivated in Taegu in 1995[†].

| Collected line name | Flower color | Flowering date | Maturing date | Plant height | Branch number | 100-seed weight | Seed yield |
|---------------------|--------------|-----------------|---------------|--------------|---------------|-----------------|-------------|
| | | - Mon. · Date - | | - cm - | - no. - | - g - | - MT / ha - |
| Kapyong 1-1 | P | Jul. 22 | Oct. 20 | 53 | 6.1 | 12.4 | 1.61 |
| Kapyong 2-2 | W | Jul. 21 | Oct. 20 | 56 | 8.6 | 11.1 | 1.02 |
| Kangwon 1-1 | P | Jul. 19 | Oct. 21 | 44 | 6.3 | 11.2 | 0.38 |
| Kangwon 1-1-1 | W | Jul. 19 | Oct. 17 | 43 | 9.4 | 11.6 | 1.36 |
| Kangwon 2-1 | P | Jul. 20 | Oct. 21 | 76 | 6.4 | 11.3 | 0.63 |
| Kangwon 3-1 | P | Jul. 21 | Oct. 25 | 45 | 7.2 | 12.2 | 0.86 |
| Kangwon 4-1 | P | Jul. 22 | Oct. 21 | 55 | 4.4 | 12.7 | 0.89 |
| Kangwon 5-1 | P | Jul. 20 | Oct. 20 | 97 | 6.5 | 12.3 | 0.98 |
| Kangwon 6 | P | Jul. 24 | Oct. 21 | 49 | 5.8 | 12.2 | 1.82 |
| Kangwon 7-2 | W | Jul. 19 | Oct. 18 | 59 | 5.0 | 11.6 | 1.36 |
| Kangwon 8-1 | P | Jul. 25 | Oct. 22 | 87 | 7.2 | 15.0 | 0.51 |
| Kyonggi 2 | P | Jul. 15 | Oct. 17 | 36 | 5.4 | 12.4 | 0.83 |
| Kyongnam 2 | P | Jul. 24 | Oct. 23 | 46 | 6.8 | 10.2 | 0.31 |
| Kyongsan 1 | P | Jul. 18 | Oct. 21 | 69 | 6.2 | 14.2 | 1.37 |
| Kurye 1-2 | W | Jul. 20 | Oct. 20 | 45 | 7.0 | 11.5 | 1.16 |
| Kurye 2-1 | P | Jul. 17 | Oct. 19 | 59 | 6.8 | 13.6 | 2.96 |
| Yangpyong 1 | P | Jul. 20 | Oct. 20 | 61 | 5.6 | 11.7 | 1.80 |
| Yongchon 1-1 | P | Jul. 22 | Oct. 22 | 53 | 6.2 | 12.6 | 2.45 |
| Yongchon 2-2 | W | Jul. 20 | Oct. 20 | 47 | 6.0 | 11.2 | 1.17 |
| Wonju 1 | P | Jul. 18 | Oct. 20 | 43 | 5.8 | 11.5 | 0.64 |
| Jeonla | P | Jul. 19 | Oct. 19 | 45 | 6.8 | 10.9 | 1.39 |
| Chongyang | P | Jul. 23 | Oct. 22 | 57 | 6.8 | 10.3 | 1.02 |
| Chungnam 1-1 | P | Jul. 19 | Oct. 17 | 57 | 7.4 | 11.6 | 1.94 |
| Hadong 1-2 | W | Jul. 19 | Oct. 20 | 41 | 7.1 | 12.0 | 1.48 |
| Hadong 2-1 | P | Jul. 18 | Oct. 20 | 48 | 6.4 | 12.3 | 1.98 |
| Hongsong 1 | P | Jul. 18 | Oct. 19 | 50 | 7.8 | 10.7 | 1.25 |
| Hongchon | P | Jul. 18 | Oct. 18 | 57 | 5.2 | 13.0 | 1.40 |
| Hwangkeumkong | P | Jul. 17 | Oct. 21 | 42 | 3.6 | 18.8 | 0.92 |
| Williams 79 | W | Jul. 15 | Oct. 18 | 81 | 3.8 | 16.4 | 1.84 |
| LSD _{0.05} | - | - | - | 5 | 0.5 | 1.3 | 0.35 |

[†] Planting date: May 20, 1995.

In Milyang experiments (Table 5) twenty-seven lines of medicinal soybeans as in Taegu experiments were tested for the investigation of growth characteristics and seed yield. Planting date in the experiments was June 17. Flowering dates of the lines ranged from August 5 to August 12 when compared to August 5 of the control cultivar Geomjeongkong 1. Maturing dates of the lines ranged from October 10 to October 19 compared to October 11 of the control cultivar. Flowering and maturing dates of the lines were delayed when compared to the control cultivar as in other locations. Shorter or taller plant heights of the lines were found, compared to the control cultivar. More branch numbers were also observed in the lines when compared to the control. One hundred-seed weights of the lines ranged from 9.1 to 14.7 g and that of the control cultivar was 24.5 g, showing similar results with other locations. Seed yields of the lines ranged from 1.04 to 2.99 MT/ha and seed yield of

the control cultivar was 1.88 MT/ha. Twelve lines of medicinal soybeans showed higher yields than did the control cultivar. Similar results were also found on the growth characteristics, one hundred-seed weight, and seed yield, showing the same trends in other areas and years.

Seed yields of the collected medicinal soybean lines were averaged across locations and years as shown in Table 6. Mean seed yields ranged from 1.54 to 2.89 MT/ha. Nine lines, Kapyong 1-1, Kangwon 8-1, Kurye 2-1, Yongchon 1-1, Yongchon 2-2, Jeonla, Hadong 1-2, Hadong 2-1, and Hongchon, among 27 observed medicinal soybeans showed over 2.50 MT/ha seed yields, indicating high yield potentials. Based on the experimental results, this study concluded that further research for selection and more evaluation of these high yielding lines is needed for the improvements of production systems and breeding programs.

Table 4. Growth characteristics and seed yield of collected medicinal soybeans cultivated in Namyangju in 1996[†].

| Collected line name | Flower color | Flowering date | Maturing date | Plant height | Branch number | 100-seed weight | Seed yield |
|---------------------|--------------|-----------------|---------------|--------------|---------------|-----------------|-------------|
| | | — Mon. · Date — | | — cm — | — no. — | — g — | — MT / ha — |
| Kapyong 1-1 | P | Jul. 24 | Oct. 8 | 67 | 7.3 | 11.0 | 3.38 |
| Kapyong 2-1 | P | Jul. 27 | Oct. 1 | 65 | 8.7 | 11.5 | 2.50 |
| Kapyong 2-2 | W | Jul. 28 | Oct. 1 | 92 | 11.7 | 8.8 | 1.58 |
| Kangwon 1-1 | P | Jul. 29 | Oct. 10 | 65 | 8.3 | 10.6 | 2.01 |
| Kangwon 1-2 | W | Jul. 27 | Oct. 4 | 57 | 8.7 | 11.2 | 2.06 |
| Kangwon 1-1-1 | W | Jul. 27 | Oct. 1 | 62 | 7.7 | 10.0 | 2.09 |
| Kangwon 2-1 | P | Jul. 29 | Oct. 8 | 78 | 9.7 | 10.7 | 2.44 |
| Kangwon 2-3 | P | Jul. 24 | Oct. 4 | 98 | 12.0 | 9.3 | 1.88 |
| Kangwon 3-1 | P | Jul. 24 | Sep. 25 | 44 | 7.7 | 11.0 | 2.26 |
| Kangwon 3-2 | W | Jul. 27 | Oct. 1 | 60 | 9.3 | 11.4 | 3.21 |
| Kangwon 4-1 | P | Jul. 27 | Oct. 8 | 58 | 6.3 | 9.2 | 1.74 |
| Kangwon 4-3 | W | Jul. 24 | Oct. 1 | 50 | 6.7 | 10.6 | 2.49 |
| Kangwon 5-1 | P | Jul. 29 | Oct. 1 | 52 | 8.7 | 9.6 | 1.92 |
| Kangwon 5-2 | P | Aug. 2 | Oct. 15 | 110 | 8.3 | 10.6 | 2.32 |
| Kangwon 5-3 | W | Jul. 28 | Oct. 15 | 65 | 6.3 | 11.3 | 1.82 |
| Kangwon 6 | P | Jul. 24 | Oct. 4 | 52 | 6.7 | 10.1 | 2.21 |
| Kangwon 7-1 | P | Jul. 29 | Oct. 10 | 65 | 6.3 | 11.6 | 1.94 |
| Kangwon 7-2 | W | Jul. 27 | Oct. 10 | 65 | 8.0 | 11.3 | 2.23 |
| Kangwon 8-1 | P | Jul. 27 | Oct. 10 | 73 | 9.7 | 13.2 | 4.43 |
| Kyunggi 2 | P | Jul. 19 | Oct. 1 | 58 | 6.7 | 13.2 | 2.26 |
| Kyonggi 2-1-1 | P | Jul. 27 | Oct. 5 | 78 | 8.0 | 12.0 | 2.44 |
| Kyonggi 2-1-2 | W | Aug. 1 | Oct. 15 | 62 | 8.3 | 12.0 | 2.51 |
| Kyongnam 2 | P | Jul. 27 | Oct. 15 | 70 | 10.0 | 11.6 | 3.47 |
| Kyongsan 1 | P | Jul. 27 | Oct. 15 | 67 | 7.3 | 11.3 | 2.83 |
| Kurye 1-2 | W | Jul. 27 | Oct. 8 | 58 | 10.3 | 11.6 | 2.73 |
| Kurye 2-1 | P | Jul. 27 | Oct. 1 | 72 | 9.0 | 10.9 | 2.64 |
| Kurye 2-2 | W | Jul. 27 | Oct. 1 | 65 | 8.7 | 11.7 | 3.31 |
| Puan 1-2 | W | Jul. 24 | Oct. 4 | 58 | 9.7 | 11.2 | 3.76 |
| Yangpyong 1 | P | Jul. 27 | Oct. 4 | 68 | 6.7 | 10.8 | 2.81 |
| Yangpyong 3 | W | Jul. 29 | Oct. 15 | 60 | 8.3 | 11.1 | 3.18 |
| Yongchon 1-1 | P | Jul. 29 | Oct. 15 | 55 | 8.3 | 10.5 | 2.57 |
| Yongchon 1-2 | W | Jul. 29 | Oct. 15 | 67 | 8.3 | 12.0 | 3.93 |
| Yongchon 2-2 | W | Jul. 27 | Oct. 15 | 62 | 10.3 | 11.7 | 3.50 |
| Wonju 1 | P | Jul. 24 | Oct. 4 | 60 | 8.0 | 9.6 | 2.88 |
| Jeonla | P | Jul. 27 | Oct. 15 | 48 | 7.7 | 9.9 | 3.60 |
| Chongyang | P | Aug. 2 | Oct. 15 | 55 | 15.7 | 9.0 | 2.91 |
| Chungnam 1-1 | P | Jul. 22 | Sep. 29 | 44 | 6.7 | 10.5 | 1.96 |
| Hadong 1-2 | W | Jul. 22 | Oct. 4 | 60 | 8.0 | 11.7 | 4.36 |
| Hadong 2-1 | P | Jul. 29 | Oct. 15 | 62 | 11.0 | 10.7 | 3.23 |
| Hongsong 1 | P | Jul. 29 | Oct. 15 | 70 | 8.3 | 14.7 | 3.94 |
| Hongchon | P | Jul. 22 | Oct. 1 | 53 | 5.0 | 12.3 | 2.59 |
| Kangwon 4-1-1 | P | Aug. 6 | Oct. 15 | 73 | 6.0 | 9.6 | 2.13 |
| Puan 2 | P | Jul. 29 | Oct. 10 | 92 | 8.3 | 13.2 | 3.74 |
| Yungdong 2 | W | Jul. 27 | Oct. 1 | 67 | 10.3 | 11.4 | 3.46 |
| Hwangkeumkong | P | Jul. 22 | Oct. 8 | 80 | 4.0 | 31.0 | 3.00 |
| Geomjeongkong 1 | W | Jul. 22 | Oct. 8 | 80 | 5.3 | 34.7 | 3.07 |
| LSD _{0.05} | — | — | — | 7 | 1.9 | 1.3 | 0.25 |

[†] Planting date: May 23, 1996.

Table 5. Growth characteristics and seed yield of collected medicinal soybean cultivated in Milyang in 1996[†].

| Collected line name | Flower color | Flowering date | Maturing date | Plant height | Branch number | 100-seed weight | Seed yield |
|---------------------|--------------|-----------------|---------------|--------------|---------------|-----------------|------------|
| | | - Mon. · Date - | | - cm - | - no. - | - g - | - MT /ha - |
| Kapyong 1-1 | P | Aug. 11 | Oct. 16 | 75 | 3.7 | 10.5 | 2.17 |
| Kapyong 2-2 | W | Aug. 7 | Oct. 15 | 80 | 3.8 | 10.8 | 2.76 |
| Kangwon 1-1 | P | Aug. 10 | Oct. 10 | 76 | 4.4 | 9.2 | 1.05 |
| Kangwon 1-1-1 | W | Aug. 9 | Oct. 11 | 68 | 2.8 | 11.3 | 2.06 |
| Kangwon 2-1 | P | Aug. 9 | Oct. 16 | 91 | 5.1 | 10.9 | 1.63 |
| Kangwon 3-1 | P | Aug. 12 | Oct. 16 | 73 | 4.1 | 10.2 | 2.31 |
| Kangwon 4-1 | P | Aug. 12 | Oct. 16 | 85 | 4.4 | 10.6 | 2.99 |
| Kangwon 5-1 | P | Aug. 10 | Oct. 15 | 109 | 5.7 | 11.4 | 1.35 |
| Kangwon 6 | P | Aug. 8 | Oct. 16 | 74 | 4.3 | 10.9 | 2.54 |
| Kangwon 7-2 | W | Aug. 16 | Oct. 12 | 76 | 4.7 | 12.1 | 1.76 |
| Kangwon 8-1 | P | Aug. 11 | Oct. 19 | 94 | 5.8 | 13.3 | 1.75 |
| Kyonggi 2 | P | Aug. 4 | Sep. 14 | 70 | 3.8 | 14.7 | 1.68 |
| Kyongnam 2 | P | Aug. 11 | Oct. 18 | 82 | 5.2 | 11.0 | 1.86 |
| Kyongsan 1 | P | Aug. 9 | Oct. 17 | 79 | 4.1 | 12.9 | 2.10 |
| Kurye 1-2 | W | Aug. 8 | Oct. 14 | 70 | 4.1 | 10.7 | 1.78 |
| Kurye 2-1 | P | Aug. 10 | Oct. 14 | 81 | 3.4 | 11.8 | 2.38 |
| Yangpyong 1 | P | Aug. 10 | Oct. 17 | 76 | 3.5 | 11.7 | 0.77 |
| Yongchon 1-1 | P | Aug. 10 | Oct. 16 | 77 | 5.0 | 9.3 | 1.47 |
| Yongchon 2-2 | W | Aug. 11 | Oct. 14 | 74 | 4.1 | 10.4 | 2.41 |
| Wonju 1 | P | Aug. 5 | Oct. 13 | 62 | 3.9 | 10.7 | 1.04 |
| Jeonla | P | Aug. 11 | Oct. 17 | 67 | 4.0 | 10.2 | 2.13 |
| Chongyang | P | Aug. 10 | Oct. 16 | 80 | 4.0 | 9.1 | 1.43 |
| Chungnam 1-1 | P | Aug. 9 | Oct. 13 | 74 | 5.1 | 10.7 | 1.21 |
| Hadong 1-2 | W | Aug. 5 | Oct. 14 | 70 | 3.9 | 12.5 | 1.45 |
| Hadong 2-1 | P | Aug. 11 | Oct. 17 | 78 | 3.9 | 12.1 | 2.10 |
| Hongsong 1 | P | Aug. 8 | Oct. 15 | 76 | 3.9 | 12.3 | 1.70 |
| Hongchon | P | Aug. 10 | Oct. 15 | 80 | 4.8 | 11.5 | 2.16 |
| Mallikong | P | Aug. 4 | Oct. 11 | 77 | 3.5 | 25.6 | 2.60 |
| Geomjeongkong 1 | W | Aug. 5 | Oct. 11 | 84 | 3.9 | 24.5 | 1.88 |
| LSD _{0.05} | - | - | - | 6 | 0.7 | 1.3 | 0.32 |

[†] Planting date: June 17, 1996.

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Table 6. Summary of cultivated location and year in seed yield (MT/ha) of collected medicinal soybeans.

| Collected line name | Location | | Year | | Mean |
|---------------------|---------------|-----------|------|------|------|
| | Taegu-Milyang | Namyangju | 1995 | 1996 | |
| Kapyong 1-1 | 1.89 | 3.88 | 3.00 | 2.78 | 2.89 |
| Kapyong 2-2 | 1.89 | 2.37 | 2.09 | 2.17 | 2.13 |
| Kangwon 1-1 | 0.72 | 2.63 | 1.82 | 1.53 | 1.68 |
| Kangwon 1-1-1 | 1.71 | 2.15 | 1.79 | 2.08 | 1.94 |
| Kangwon 2-1 | 1.13 | 2.99 | 2.08 | 2.04 | 2.06 |
| Kangwon 3-1 | 1.59 | 2.49 | 1.79 | 2.29 | 2.04 |
| Kangwon 4-1 | 1.94 | 2.62 | 2.20 | 2.37 | 2.29 |
| Kangwon 5-1 | 1.17 | 1.90 | 1.43 | 1.64 | 1.54 |
| Kangwon 6 | 2.18 | 2.24 | 2.04 | 2.38 | 2.21 |
| Kangwon 7-2 | 1.56 | 3.11 | 2.67 | 2.00 | 2.34 |
| Kangwon 8-1 | 1.13 | 3.87 | 1.91 | 3.09 | 2.50 |
| Kyonggi 2 | 1.26 | 2.29 | 1.58 | 1.97 | 1.78 |
| Kyongnam 2 | 1.09 | 3.87 | 2.29 | 2.67 | 2.48 |
| Kyongsan 1 | 1.74 | 3.19 | 2.46 | 2.47 | 2.47 |
| Kurye 1-2 | 1.47 | 2.80 | 2.01 | 2.26 | 2.14 |
| Kurye 2-1 | 2.67 | 2.94 | 3.10 | 2.51 | 2.81 |
| Yangpyong 1 | 1.29 | 3.05 | 2.54 | 1.79 | 2.17 |
| Yongchon 1-1 | 1.96 | 3.04 | 2.98 | 2.02 | 2.50 |
| Yongchon 2-2 | 1.79 | 3.56 | 2.39 | 2.96 | 2.68 |
| Wonju 1 | 0.84 | 3.43 | 2.31 | 1.96 | 2.14 |
| Jeonla | 1.76 | 3.24 | 2.13 | 2.87 | 2.50 |
| Chongyang | 1.23 | 3.14 | 2.20 | 2.17 | 2.19 |
| Chungnam 1-1 | 1.58 | 2.32 | 2.31 | 1.59 | 1.95 |
| Hadong 1-2 | 1.47 | 3.55 | 2.11 | 2.91 | 2.51 |
| Hadong 2-1 | 2.04 | 3.16 | 2.53 | 2.67 | 2.60 |
| Hongsong 1 | 1.48 | 3.46 | 2.11 | 2.82 | 2.47 |
| Hongchon | 1.78 | 3.29 | 2.70 | 2.38 | 2.54 |
| Hwangkeumkong | 0.92 | 2.67 | 1.63 | 3.00 | 2.06 |
| Geomjeongkong 1 | 1.88 | 3.04 | 3.00 | 2.48 | 2.60 |
| Williams 79 | 1.84 | — | 1.84 | — | 1.84 |
| Mallikong | 2.60 | — | — | 2.60 | 2.60 |

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