Soybean Cultivar, “Choseon” : Cultivar with Yellow Medium Seed Size and Lipoxxygenase 2,3 Protein-free

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Abstract : Soybean [*Glycine max* (L.) Merr.] is an important source for protein, oil, carbohydrates, isoflavones, and many other nutrients to humans and animals. Lipoxxygenase protein is the main antinutritional factor in mature soybean seed. Soybean cultivar, "Choseon" with yellow medium seed size and free of lipoxxygenase 2,3 protein was developed. "Choseon" was selected from the population derived from the cross between cultivar, "Jinpum 2" and germplasm, PI408155. "Choseon" has purple flowers, tawny pubescence, a determinate growth habit, and light yellow pods at maturity. The seed of "Choseon" has yellow hilum and yellow seed coat color. Seed protein and oil content on a dry weight basis were 34.2 and 16.9%, respectively. "Choseon" has shown a resistant reaction to soybean necrosis, soybean mosaic virus, *Cercospora* leaf spot and blight, black root rot, pod and stem blight, and bacterial pustule. "Choseon" matured in 5 October with plant height of 51 cm and a 100-seed weight of 15.1 g. Average yield of "Choseon" was 2.66 (Ton/ha) on the regional yield trials of 2013 at 4 locations. "Choseon" has been registered as a soybean cultivar (registration number: 5985, registration date: April 11, 2016) by Korea Seed & Variety Service, Republic of Korea.

Keywords : Soybean, Choseon, Lipoxxygenase, Yellow seed, Medium seed size

INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is widely grown for food and feed products. Demand of soybean products has increased by high quality of protein with essential amino acids, vitamins, fibre, essential fatty acids, phytochemicals, and lecithins (Obendorf et al. 2008). Lipoxxygenase protein is the major antinutritional factor in mature soybean seeds. End-products of lipoxxygenase activity are converted to many volatile compounds, which are responsible for the beany flavor associated with soybean products. In soybean seeds, lipoxxygenase proteins constitute about 1–2% of the protein. Lipoxxygenase protein can be isolated as three isoenzymatic forms. Lipoxxygenase proteins are controlled by single dominant genes i.e. *Lx1*, *Lx2* and *Lx3*, while absence is ascribed to corresponding recessive alleles (*lx1*, *lx2*, *lx3*). The studies on inheritance and genetic elimination of lipoxxygenase protein

were reported (Hildebrand & Hymowitz 1981, Davies & Nielsen 1986, Kitamura et al. 1983). Genotypes with lipoxxygenase free are better accepted due to production of very low levels of hexanal compounds (Kobayashi et al. 1995). Heat inactivation of the lipoxxygenase at industrial level not only incurs extra cost but also affects the solubility and functionality of proteins (Macleod & Ames 1988). Development of genotypes with lipoxxygenase free through genetic elimination is the key to get rid of the beany-flavour. So far, a few cultivars with lipoxxygenase protein free have been developed (Kim et al. 1997, Chung 2009). However, soybean cultivars with yellow medium seed size and free of lipoxxygenase protein for use as sprout or natto were not released. Soybean cultivar with yellow medium seed size and free of lipoxxygenase 2,3 protein was developed.

MATERIALS AND METHODS

Two parents were used to improve new lines with traits of yellow seed coat, medium seed size, and free of lipoxxygenase 2,3 protein. The Cultivar, "Jinpum 2" used as

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Fig. 1. Pedigree diagram of "Choseon". ^{z)}: Preliminary yield trial, ^{y)}: Advanced yield trial, ^{x)}: Regional yield trial.

Table 1. Qualitative characteristics of Choseon.

Cultivar	Growth habit	Flower color	Leaf shape	Pubescence color	Seed coat color	Hilum color	Cotyledon color
Choseon	Determinate	Purple	Oval	Tawny	Yellow	Yellow	Yellow
Pungsannamulkong	Determinate	Purple	Oval	Tawny	Yellow	Yellow	Yellow

female has traits of yellow seed coat, little large seed size (23.5 g/100 seed), and free of lipoxxygenase 1,2,3 protein (Kim et al. 1997). Soybean germplasm, PI408155 used as male parent has yellow seed coat, small seed size (6.6 g/100 seed) and lipoxxygenase protein-present. F₁ seeds from the cross were obtained and were planted at greenhouse in 2003. Presence or absence of lipoxxygenase protein in each of the F₂ seed was tested by SDS-PAGE protein analysis (Sathe 1991). F₂ seeds were planted in May 2004. Single F₂ plants were harvested based on plant type, height and maturity. Twenty lines with lipoxxygenase 2,3 protein free were planted and harvested in 2005 and 2006. Pedigree selection method was used through F₅ and F₇ generation to select plants with yellow seed coat, medium seed size and free of lipoxxygenase 2, 3 protein. One F₈ line with acceptable agronomical traits such as flowering date, maturity date, growth habit, plant type, lodging and seed quality was selected in 2010. Qualitative traits were recorded in 2011 and 2012 at Jinju location. Agronomic traits such as lodging, shattering and

reaction to disease were recorded according to standard soybean cultivation manual of RDA, Korea. Yield, protein and oil content, and insect resistance were tested in Korea Seed & Variety Service. Selection procedures are shown in Figure 1.

RESULTS AND DISCUSSION

Agronomic performance

Qualitative traits of "Choseon" are shown in Table 1. "Choseon" has purple flowers, tawny pubescence, a determinate growth habit, oval leaflet shape, and light yellow pods at maturity. The seed of "Choseon" has yellow hilum and yellow seed coat color. Cotyledon color of mature seed is yellow.

Quantative traits of "Choseon" are shown in Table 2. "Choseon" flowered in August 1, which is 2 days earlier than "Pungsannamulkong". "Choseon" matured in October 3, which is 2 days earlier than "Pungsannamulkong". Plant

Table 2. Quantitative characteristics of Choseon determined by regional yield trial in 2013.

Cultivar	Flowering date	Maturity date	Plant height(cm)	Lodging ^{z)} (0-9)	100-seed weight (g)	Shattering ^{y)} (0-9)
Choseon	August 1	Oct. 3	51±1.2a ^{x)}	0	15.1±0.68a ^{x)}	3.0
Pungsannamulkong	August 3	Oct. 5	62±2.7b	1	12.3±0.12b	2.5

^{z)} 0: not lodged, 9:completely lodged.

^{y)} 0: no shattering, 9:completely shattering.

^{x)} Mean ± Standard Error, different letters in the column are significantly different by DMRT at 5%.

Table 3. Yield of Choseon on the regional yield trials of 2013 at 4 locations.

Location	Choseon (Ton/ha)	Pungsannamulkong (Ton/ha)
Jinju	2.80	2.90
Sachun	2.70	2.85
Miryang	2.65	2.92
Muan	2.50	2.70
Mean	2.66	2.84
t-value 1.91 ^{ns}		

^{ns}: Not significant

Table 4. Characteristics for seed components of Choseon estimated in 2013 at Miryang.

Cultivar	Crude protein (%)	Crude oil (%)	Lipoxygenase 2,3 protein
Choseon	34.2	16.9	Absent
Punsangnamulkong	35.0	18.1	present

Fig. 2. Phenotype of Choseon cultivar. ①: appearance of V6 stage in field, ②: appearance of R8 stage in field, ③: seed of harvested.

height of "Choseon" was 51 cm compared to the check cultivar of 62 cm. Lodging score of "Choseon" was 0. The 100-seed weight of "Choseon" was 15.1 g larger than that of "Pungsannamulkong"(12.3 g). "Choseon" had a shattering score of 3.0 versus "Pungsannamulkong" with a score of 2.5. Average yield of "Choseon" (Jinju location) was 2.7

– 2.9 ton/ha in 2012 – 2013.

Yield of "Choseon" was shown in Table 3. Average yield of "Choseon" was 2.66 (Ton/ha) on the regional yield trials of 2013 at 4 locations.

Traits for seed components of "Choseon" are shown in Table 4. Average seed protein and oil content on a dry weight

Table 5. Resistant degree of Choseon to soybean disease estimated in 2013.

Cultivar	Necrosis (0-9) ^{z)}	Mosaic virus (0-9)	Cercospora leaf spot and blight (0-9)	Black root rot (0-9)	Pod and stem light (0-9)	Bacterial pustule (0-9)
Choseon	0	0.5	2	0	1	0
Pungsannamulkong	0	1.0	2	0	1	1

^{z)} 0: Resistant, 9: susceptible.

basis were 34.2% and 16.9%, respectively compared to 35.0% and 18.1% of the check cultivar, "Pungsannamulkong". Lipoygenase 2, 3 protein was absent in "Choseon", but was present in "Pungsannamulkong".

Plants and seeds of "Choseon" are shown in Figure 2.

Disease Resistance

Reaction of "Choseon" to soybean diseases is shown in Table 5. "Choseon" was resistant to soybean necrosis similar to check cultivar (0 score). Also, both cultivars "Choseon" and "Pungsannamulkong" were resistant to soybean mosaic. "Choseon" was resistant to Cercospora leaf spot and blight, black root rot, pod and stem blight. Score of resistance to Bacterial pustule in "Choseon" was higher than "Pungsannamulkong" with a score of 0 and 1, respectively.

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