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Gui Valley: A High Yielding Potential and Good Processing Potato Cultivar

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Abstract - The main objective of this breeding program is to develop high yielding, disease resistance and good processing potato cultivar. 'Gui Valley' is a clonal selection resulting from a cross between 'ND2471-8' and 'Cona'. It has medium plant height and light green foliage. 'Gui Valley' has medium flowering habit and light pink flowers. 'Gui Valley' is a medium maturing potato cultivar and tubers are smooth, yellow skin, light yellow flesh, long-oval tuber shape, distinct red eyes with medium depth and medium dormancy. It has high level of tuber uniformity and good keeping quality. 'Gui Valley' demonstrates resistance to potato virus Y (PVY), soft rot, but moderately susceptible to late blight and common scab. It is also resistant to most of the internal and external physiological disorders particularly dehiscence, hollow heart and internal brown spot. The specific gravity of 'Gui Valley' is significantly higher (1.097) than that of 'Shepody' (1.078). 'Gui Valley' has suitable for processing mainly French fries and chips. This cultivar has high level of tuber uniformity and capable of yielding 37.6 $t \cdot ha^{-1}$, which is 18.2% higher than the control potato cultivar 'Shepody' under optimum agronomical practices.

Key words - Chips, French fries, physiological disorder, potato, specific gravity, *Solanum tuberosum*

Introduction

Plant breeding is an art, it is done to achieve the desired variation and also to manipulate producing a stable new cultivar. Originally, potato (*Solanum tuberosum* L.) is considered as a long day plant. By rapid development of new potato varieties, mainly through the breeding program it is possible to cultivate in wide geographical ranges with extremes of temperature and humidity. From an ecological and phytogeographical viewpoint, some potatoes exhibit a wide diversity of resistance to fungal, bacterial and virus diseases, as well as to insect, arachnid, and nematode pests (Hawkes, 1990). The systematic effort to improve the productivity of potato in Korea was started only from 1960s with the establishment of Potato Research Program (Kim, 1999). Recently, it has resulted in remarkable increase in the productivity of the potato in the country. The progress so far achieved in improving the productivity of potatoes is mainly due to the development of new high yielding, disease resistant varieties having other physiological characters. In the past, potatoes for Korea were known as inferior food to supplement the lack of rice. But, now, it is possible to grow all year round. After starting the breeding program in the country several potato varieties having with high quality, early maturity, and short dormancy have been developed. Having these important characteristics in 'Valley Potato', we are introducing these varieties to the other major potato growing countries such as China, Mongolia, Kazakhstan, Russia, Canada, USA, India, and Nepal for all round cultivation and high yielding, use as functional foods or table and processing purposes (Lim *et al.*, 2008). Furthermore, considering these possibilities breeding was done using a diverse genetic background of potato varieties with the main objectives to development of high yielding, disease resistance, and high processing quality potato cultivar.

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Materials and Methods

'Gui Valley' originated from a cross between 'ND2471-8' and 'Cona'. The cross was made by the Agriculture Research Service Geneticist Dr. Joseph Pavek, located at University of Idaho, Aberdeen Research and Extension Center, USA. Seeds from the cross were imported into Korea, where subsequent clonal selection was completed. In 1997, hybrid seeds were planted in individual pots under a net-house at Chuncheon. Seedlings produced approximately 500 minitubers which were stored and planted into the field in the fall season of the same year and selected about 160 clones. In 1998, seven clones were selected and given the clonal designation 'Lim's Valley 90'. From these seven clones, two clones were selected in 1999 based on the results of advanced evaluation trials. In 2000, one clone from this family was selected and further evaluated for two years in replicated yield trials (20 tubers in three replications) in three agro-ecological regions i.e. south hills (Gimje), north hills (Chuncheon), and north mountains (Daegwallyeong) in Korea. In 2002, named 'Gui Valley' and it has been entered into advanced yield trials in other part of the country (Fig. 1). Subsequent seed propagation and commercial trials of 'Gui Valley' were conducted at Gimje, Chuncheon and Daegwallyeong.

Trials conducted in 2000 to 2002 at Gimje, Chuncheon, and Daegwallyeong were used to document the morphological and agronomic characteristics of 'Gui Valley'. Descriptions were developed describing the morphology of the plants, tubers, leaves, and flowers (Lim *et al*., 2009; Mosley *et al*., 2003; http://www.upov.int). Measurements were also made about agronomical characteristics, yield and tuber quality during and after harvesting. Evaluation of new potato cultivar on the processing quality (French fries, chips) and taste evaluation (boiled and microwaved) (Novy *et al*., 2002) were conducted at Potato Laboratory, Kangwon National University, Chuncheon. Similarly, common scab, late blight, and virus evaluation trials were conducted at Chuncheon under naturally infected field conditions and consisted of three replicates in a randomized complete block design for assigning disease reactions (CIP, 1996; Henfling, 1987; Hooker, 1986). Assignments of disease resistant ratings were based on a three years of replicated field evaluation trials. The potato cultivar 'Shepody' was used as a standard control in the trials and, where appropriate.

Results and Discussion

Varietal Description

The plant, flower, tuber, and sprout of 'Gui Valley' are described and shown in Table 1 and Fig. 2. Plants are medium (62 cm) in height, semi-upright growth habit and oval leaf shape (Fig. 2A). Flowers are light pink in color and profuse

Year	1996	1997 (Spring)	1997 (Fall)	1998	1999	2000	2001	2002
Generation	Crossing	G1	G2	G3	G4	G5	G6	G7
ND2471-8 × Cona		Seedling 1 • • Seedling 500	Valley • •	Valley • •	Lim's Valley 90 •	Lim's Valley 90	Lim's Valley 90	Gui Valley
No. of lines		500	160	7	2	1	1	1
Procedure	Artificial crossing	Individual seedling selection	1st Evaluation trial	2nd Evaluation trial	3rd Evaluation trial	Replicated yield trial	Replicated yield trial	Replicated yield trial

Fig. 1. Pedigree diagram of the new potato cultivar 'Gui Valley'.

flowering habit (Fig. 2B), sprouts are light red in color (Fig. 2C), yellow tuber skin, long-oval shape, distinct red eyes with medium depth (Fig. 2D), and light yellow flesh color (Fig. 2E).

Agronomic performance

'Gui Valley' is a medium maturing (110 days), medium tuber dormancy (102 days), similar to control cultivar 'Shepody' (dormancy 106 days). Due to wide adaptability it can be grown from southern hills to northern mountains of Korea. Tubers are large in size (average 202 g/tuber) with good tuber yield (Table 2). This cultivar has high yield potential (37.6 t·ha^{-1}), which is 18.2% higher than the yield of control potato cultivar 'Shepody' (31.8 t·ha^{-1}) and good marketable tuber yield

Table 1. Morphological characteristics of the new potato cv. 'Gui Valley'

Cultivar	Plant		Leaf		Flower	Tuber			
	Height (cm)	Shape	Shape	Color	color	Shape	Skin color	Fresh color	Eye depth
Gui Valley	Medium (62)	Semi-upright	Oval	Green	Light pink	Long-oval	Yellow	Light yellow	Medium
Shepody	Medium (60)	Semi-upright	Oval	Green	White	Long	Yellow	Light yellow	Medium deep

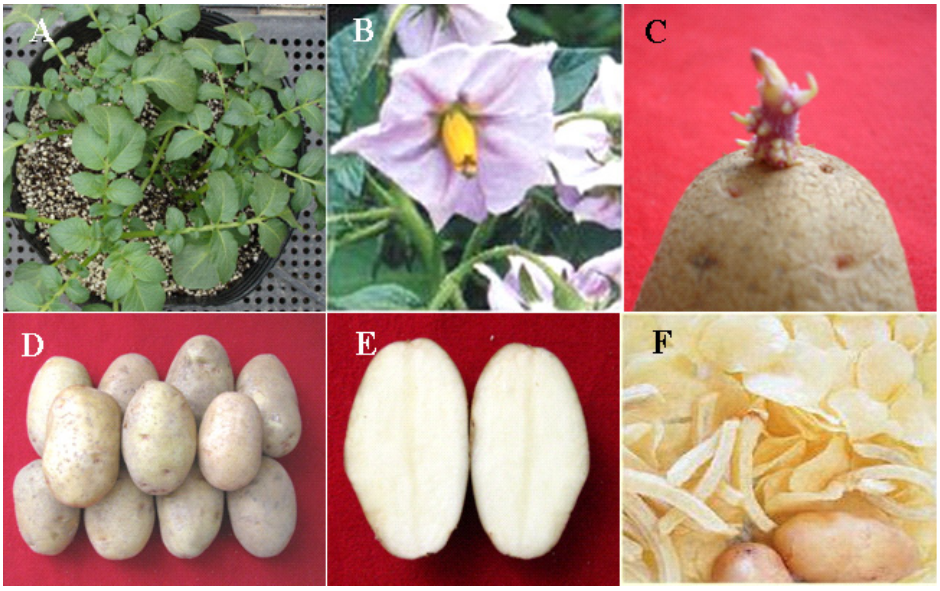

Fig. 2. Plant and leaf (A), flower (B), sprout (C), tuber (D), flesh (E) and, chips and French (F) fries characteristics of the new potato cultivar 'Gui Valley'.

Table 2. Agronomic characteristics of the new potato cultivar 'Gui Valley' evaluated under regional yield trials at Gimje, Chuncheon and Daegwallyeong during 2000 to 2002

Cultivar	Tuber dormancy (days)	Maturation period (days)	Tuber (no./plant)	Tuber weight (g/tuber)	Total yield (g/plant)
Gui Valley	Medium (102)	Medium (110)	5.3±0.4^{z}	202.2±15.9	1000±35.5
Shepody	Medium(106)	Medium (115)	4.8±0.3	204.5±13.5	980±37.8

^{z}Data are presented as mean ± standard error.

under optimum agronomical practices (Table 3). However, in the case of Daegwallyeong, the seeds of 'Gui Valley' were slightly less sprouted than that of 'Shepody', as a result cropping period of 'Gui Valley' was shorter than that of 'Shepody'.

Tuber quality and usage

Processing characteristics

'Gui Valley' is suitable for processing purposes mainly for French fries and chips (Fig. 2F). The mean specific gravity of 'Gui Valley' grown at Kimje and Chuncheon is 1.097, which is significantly higher than the 'Shepody' (1.078) (Table 4). Specific gravity, and glucose and fructose content in tuber are also important components to determine the quality of potatoes for processing.

Sensory evaluations

Taste panel evaluations of boiled and microwaved potatoes

Table 3. Yield performance of the new potato cultivar 'Gui Valley' under regional yield trial at Gimje, Chuncheon, and Daegwallyeong during 2000 to 2002

Year	Cultivar	Experimental site		
		Kimje ($t \cdot ha^{-1}$)	Chuncheon ($t \cdot ha^{-1}$)	Daegwallyeong ($t \cdot ha^{-1}$)
2000	Gui Valley	46.6±4.2[z]	32.1±4.2	41.6±3.8
	Shepody	36.4±3.6	37.8±4.4	30.4±4.0
2001	Gui Valley	40.9±3.8	30.9±3.4	38.2±4.0
	Shepody	29.0±3.2	38.8±3.9	23.7±3.9
2002	Gui Valley	39.1±3.7	27.9±3.2	40.7±3.7
	Shepody	24.8±2.9	36.9±3.7	28.0±3.5
Average	Gui Valley	42.2±5.3	30.3±2.2	40.2±2.2
	Shepody	30.1±4.9	37.8±2.1	27.4±2.8

[z]Data are presented as mean ± standard error.

Table 4. Tuber specific gravity, glucose contents and fructose contents, and French fries and chips quality of the new potato cultivar 'Gui Valley' in full season trials at Chuncheon during 2000 to 2002

Cultivar	Specific gravity[z]	Glucose (%)	Fructose (%)	French fries, chips at field fry[y]	
				Color	Taste
Gui Valley	1.097±0.003[x]	0.240±0.09	0.092±0.02	67.7±7.4	7
Shepody	1.078±0.002	0.109±0.11	0.063±0.01	54.5±7.6	4

[z]Specific gravity was determined using the weight-in-air and weight-in-water method.
[y]French fries and chips color was determined by using color-meter method where 1 = dark color; 100 = light color, and taste where 1 = worst; 9 = best.
[x]Data are presented as mean ± standard error.

Table 5. Sensory evaluation ratings for mealiness and flavor of boiled and microwaved tubers of 'Gui Valley' and 'Shepody' grown at Chuncheon, 2002

Cultivar	Boiled		Microwaved	
	Mealiness[z]	Flavor	Mealiness	Flavor
Gui Valley	7.4±0.21[y]	7.8±0.16	6.8±0.14	7.0±0.15
Shepody	5.5±0.18	5.0±0.15	5.2±0.13	5.0±0.14

[z]Mealiness and flavor evaluation rated were on a scale of 1-9, where; 1 = very poor quality and 9 = best quality.
[y]Data are presented as mean ± standard error.

show that 'Gui Valley' has good quality for fresh table use. Sensory ratings were higher than for 'Shepody' immediately after harvesting (Table 5).

Nutritional characteristics

Potato is a cheap source of mineral compounds in the human diets (McCay *et al*., 1987). Among the major mineral compounds, 'Gui Valley' has high amount of sodium, calcium, potassium, and phosphorus than the potato cv. 'Superior' (Choi *et al*., 2008). Therefore, 'Gui Valley' is expected to be valuable potato cultivar from nutritional point of view.

Tuber defects

Tubers are moderately susceptible to late blight and common scab diseases of potato under field conditions (Table 6).

Disease response and physiological disorder

Late blight (*Phytophthora infestans* (Mont.) de Bary), common scab (*Streptomyces scabies* (Thaxter) Waksman & Henrici), and viruses are the major potato diseases in Korea (Kim, 1999). Potato cultivar 'Gui Valley' is resistance to potato virus Y (PVY), soft rot, but moderately susceptible to late blight and common scab under field conditions. It also showed good resistance to most of the internal and external physiological disorders particularly dehiscence, hollow heart, and internal brown spot (Table 6).

Management

Studies on production management practices for 'Gui Valley' were conducted at three different locations, i.e. Chuncheon, Gimje and Daegwallyeong. These sites are representative of potato production area throughout Korea and results may provide growers with a foundation for the development of management guidelines specific for their locality. Seed spacing trials indicated that the optimal commercial spacing for seed pieces of 'Gui Valley' is 25 cm on rows spaced 75 cm apart. Optimal seed size ranges from 50 to 75 g and optimal planting depth is 10 to 12 cm. Seed should be checked for fungal diseases and seed treated with an effective fungicides, if needed.

Fertilizer recommendations include 225 $kg \cdot ha^{-1}$ Nitrogen, 270 $kg \cdot ha^{-1}$ Phosphorus and 180 $kg \cdot ha^{-1}$ Potassium (Lim *et al*., 2009). All fertilizers should be applied prior to planting, during final field preparation, or just prior to laying the polyethylene film (if used). 'Gui Valley' has good tolerance to water stress, but soil moisture within the root zone (0 to 40 cm soil depth) should still be maintained between 65 to 80% of available soil moisture during tuber development and bulking to maintain optimal yield and quality. Bruising should be minimized by careful handling during harvest, transport, and packaging. Comparable management practices are recommended for Gimje, Chuncheon, and Daegwallyeong, because soil types, fertility status, cropping patterns, and cultural practices are similar in all three locations.

Storage

Storability of 'Gui Valley' has been as good as that for 'Shepody'. As a result it showed good performance in the quality of French fries, chips, boiled and table potato even after long-term storage under normal conditions.

Seed availability

Disease free tissue-culture-based plant materials, i.e. micro-propagated plantlets, minitubers, and certified seeds are available from the Potato Valley Co., Ltd. 'Gui Valley' has been registered as the national potato variety (01-0005-2005-

Table 6. Disease resistance and physiological disorder of the new potato cultivars 'Gui Valley' and 'Shepody' under replicated trials at Chuncheon during 2000 to 2002

Cultivar	Late blight	Common scab	Soft rot	Virus (PVY)	Dehiscence	Hollow heart	Internal brown spot
Gui Valley	4	3	1	1	1	1	1
Shepody	1	5	3	1	1	1	1

Late blight response was rated on a scale of 1-9, where; 1 = resistance, 5 = moderately resistance, 9 = susceptible. Other diseases and physiological response were rated on a scale of 1-5, where; 1 = resistance, 3 = moderately resistance, 5 = susceptible.

3) by Korea Seed and Variety Service, Republic of Korea.

In conclusion, the new potato cultivar 'Gui Valley' has several desirable characteristics such as high yielding, medium maturing, medium dormancy, resistance to soft rot and PVY, resistance to major physiological disorders, high tuber uniformity, and suitable for French fries and chips.

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