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Seed Potato Certification in Korea[1]

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韓國의 씨감자 檢疫[1]

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ABSTRACT

Potato diseases, especially mosaics and leaf roll, appear to reduce potato yield in Korea more than any other factor. A seed potato certification program was established at the Alpine Experiment Station (AES) in 1961 to produce high quality seed potatoes for distribution to Korean farmers. The present program for production of certified seed of Namjak (Irish Cobbler), the only variety recommended for spring plantings, is outlined. In 1976, approximately 10,000 MT of certified grade Namjak seed was produced by members of two Seed Producers Cooperatives in the Daekwanryeong area for distribution by the Office of Seed Production and Distribution (OSPD). The seed was inspected and certified by officers of the National Agricultural Products Inspection Office (NAPIO).

Although the quality of the certified seed is far superior to that used by many farmers, the supply planted less than 1/5 of the 1977 potato crop. Certified seed of Shimabara, the variety recommended for autumn plantings, is not produced in Korea. The yield response of virus infected seed to improved cultural practices is poor. Therefore, an increase in potato acreage and yields appears to be possible only if more good quality seed is used by Korean farmers. A two or three fold increase in seed supply would be desirable.

The volume of seed could be increased by expanding the production area and by improving yield in seed fields. More land is available in the alpine area and good seed potatoes could be grown in other parts of Korea. Planting better quality seeds and using better cultural pracitces would improve seed yields. Several techniques could be used to improve the quality of elite seed produced at AES. Changes in seed potato certification program should be made so that healthy seed stocks of new varieties can be released rapidly.

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INTRODUCTION

Low potato (*Solanum tuberosum* L.) yield is not a new problem in Korea. Prof. Thomas H. King, plant pathology consultant to Korea, wrote in the summer of 1957:

"A hundred or more small fields of Irish potaoes were examined and found to be severely affected with the virus diseases. It was not unusual to find 40—50 percent of the plant affected, and when the crop was harvested most of the tubers were the size of chicken eggs. There are also many fungus diseases such as scab and early blight that were causiong serious losses. If a workable potato seed certification system could be developed and fungicide applied at the critical times for the control of many of the fungus diseases, it is the opinion of the advisor that potato production could be increased 300 percent."

Since then the situations has improved. A potato seed certification program has been established and average potato yields have jumped from 8.1 to 11.8 metric tons per hectare (MT/ha) in 1976 (15). Yet, consi derable improvement is needed to achieve yields obt ained in developed countries: Japan, 21 MT/ha and the Netherlands, 33 MT/ha (6).

Potato diseases are still the major factor limiting potato production in Korea. Potato fields with over 90 percent of the plants stunted by virus incited diseases are still too common. Late blight causes early maturation in many fields, especially in alpine areas. And tuber rots destroy a significant portion of the crop before or after harvest. Thus, inputs such as improved cultural practices, fertilizers, pesticides and irrigation are unlikely to be profitable until good quality potato seed is planted.

Although surveys of potato diseases in Korea are not complete, the list of potentially important disease problems should include: leaf roll incited by the potato leaf roll virus (PLRV); mild and severe mosaics, potato viruses A and Y (PVA and PVY); spindle tuber, spindle tuber viroid (PSTV); ring rot, *Corynebacterium sepedonicum*; black leg, *Erwinia carotovora* var. *atroseptica*; soft rot, *E. carotovora.* var. *carotovora*; late blight, *Phytophthora infestans*; pink rot, *Phytophora erythroseptica*; dry rot, *Fusarium* spp.; early blight, *Alternaria solani*; black scurf, *Rhizoctonia solani*; powdery scab, *Spongospora subterranea*; and common scab, *Streptomyces scabies* (see Hodgson et al. (8) and Smith (19)). Procedures for control of latent mosaic viruses, potato viruses S and X (PVS and PVX), are included in many certification programs because combined infections with PVX and PVS or severe strains of PVX can reduce potato yield (20, 21).

The recommended potato varieties are resistant to only a few of the many potato diseases found in Korea. Many of the diseases are tuber-borne and persist from one crop to the next in or on infected tubers. Seed potato certification programs are designed to control diseases and to provide farmers with better quality seed than could be obtained from his farm or from his neighbor's. Today, seed certification is the principal means of disease control in most potato growing areas of the world.

The Ministry of Agriculture and Fisheries (MAF) has been and is continuing to encourage improvement and expansion of potato production in Korea (12). Since farm land is limited, the anticipated expansion can result in multiple cropping and better land utilization. Potatoes have been shown to be profitable as a second crop in several cropping systems when good quality seed is used (9, 10, 17). Since production and distribution of good seed potatoes appears to be an essential factor in expansion of potato production, we felt that a review of the present seed potato certification program was needed.

PRODUCTION OF QUALITY SEED POTATOES

Korea's seed potato certification program was initiated in 1961 by the Office of Rural Development(ORD) at the Alpine Experiment Station (AES) to replace imported seed potatoes (2). The station is located in the Daekwanryeong area, approximately 24 kilometers west of Kangneung and 230 kilometers east of Seoul. Situated at 820 meters above sea level, AES produces elite classes of seed for distribution to other government organizations which in turn provide seed to Korean farmers.

In Korea, the production, inspection and distribution of certified seed potatoes are controlled by the Ministry of Agriculture and Fisheries through designated representatives and organizations as defined in the agricultural seed laws (13, 14).

The present seed potato certification program (Table 1) has evolved from the program started in 1961 at AES. Initially, foundation seed was distributed by AES directly to prominent seed growers who produced registered and certified seed. In 1969, the Kangwon Provincial Potato Registered Seed Farm was established in the Daekwanryeong area to produce registered potato seed for distribution to certified seed growers (16). The seed growers have been organized into Seed Producers Cooperatives under the National Agricultural Cooperative Federation (NACF). Other Provincial seed farms were later established in Gyeonggi (Kapyung), Jeonnam (Muan), Kyeongnam (Kimhae) and Jeju. The National Office of Seed Production and Distribution (OSPD) was organized in 1974 to handle certified seed of major food crops including potatoes. In 1976, OSPD accepted responsibility for distribution of certified seed produced by members of two Seed Producers Cooperatives in the Daekwanryeong area. Operation of the Kangwon Provincial Potato Registered Seed Farm was transferred to OSPD early in 1977. No provisions were made for continued production of registered potato seed at the other Provincial seed farms. Inspection services for registered and certified seed are provided by the National Agricultural Products Inspection Office (NAPIO).

Table 1. The Korean multiplication and distribution program for seed potatoes in 1976.

Class of seed	Organization responsible	Area (ha)	Volume M/T
Irish Cobbler(Namjak)			
Virus-free stock	Alpine Expt. Station	0.2	1.5
Breeder's I	〃	1.4	9.3
Breeder's II	〃	6.8	7.6
Foundation	〃	28.1	257.0
Registered	Kangwon Provincial Potato Seed Farm, Daekwanryeong	188.0	1,500.0
Certified	Seed Producers Cooperatives, Daekwanryeong	1,250.0	10,000.0
Shimabara			
Virus-free stock	Alpine Expt. Station	—	0.2
Breeder's I	〃	0.2	1.0
Breeder's II	〃	0.8	4.4
Foundation	Jeju Expt. Station	3.4	27.0
Registered	Provincial farms in Kyeongnam, Jeju and Jeonnam Provinces	22.5	180.0
Certified	?	—	—

At present certified seed of only one variety, Irish Cobbler or Namjak, is produced in Korea. Namjak is planted in approximately 80 percent of the potato area planted annually and is the only variety recommend for spring plantings. Shimabara is recommended for autumn plantings and for Jeju Island, but certified seed is not available. The remaining area is planted with old varieties and mixed seed lots. Of these the most common variety is Nangok No. 1, a late maturing cultivar with late blight and virus tolerance selected in the 1900's(2).

The seed potato certification program in Korea is a 'flush out' type where a higher class of seed must be used to produce the next lower class. The initial step is maintenance and multiplication of virus-free stocks at AES. To prevent disease infection, whole tubers from virus-free plants are planted in screen houses in new soil brought each year from surrounding forests. The systemic insecticide Di-syston is applied in the soil for aphid control. A regular spray program with Metasystox-R and Dithane M-45 is followed to reduce spread of aphid transmitted viruses and late blight. The green peach aphid, *Myzus persicae*, is the most important

vector of PVY and PLRV. The virus-free stocks are maintained by roguing out plants having virus symptoms and by serological tests for PVX, PVY,PVS, and PVM (3). The gram stain is used to check tubers for bacterial ring rot infection. After harvest, one tuber or one eye from each plant is grown in a winter greenhouse nursery and checked visually for virus symptoms. Tubers from plants with negative reactions are saved to replant the virus-free stocks the following year.

Extra tubers from the virus-free stocks are used to plant the breeder's I field. The large tubers are cut into 2 or 4 pieces which are planted adjacent to each other to form tuber units which facilitate roguing. The field is rogued to remove tuber units showing virus symptoms or wilt diseases. After harvest, tubers are checked for ring rot infection with the gram stain. Also, one eye is cut out of each tuber indexing in an autumn nursery at Kangneung or in the winter greenhouse at AES. The small plants produced are checked visually for mosaic and leaf roll symptoms. Tubers having a positive reaction in either test are discarded.

Seed from the breeder's I field is planted in tuber units to produce breeder's II seed. The fields are rogued to remove plants with mosaic, leaf roll and wilt symptoms. The breeder's II seed is used to plant foundation fields at AES (Irish Cobbler) and at the Jeju Experiment Station (Shimabara). The foundation seed fields are rogued to remove plants with mosaic or leaf roll symptoms and those with wilt or rot symptoms.

At all stages of seed production, AES fields are sprayed regularly to control late blight and aphids. A systemic insecticide is mixed with the fertilizer and incorporated into the soil at planting for early season control of aphids which spread PVY and PLRV.

After harvest of foundation seed at AES, the tubers are placed in large stacks for temporary field storage. Two to four weeks later the seed is graded to remove rotten, damaged, and off-size (small, very large, and knobby) tubers. The foundation seed is then sent to the Kangwon Provincial Potato Registered Seed Farm for winter storage and production of registered seed the following year. At the Jeju Experiment Station foundation seed of Shimabara is harvested in late June or early July and distributed to the Kyeongnam, Jeonnam, and Jeju Provincial Governments for autumn plantings.

Both registered and certified seed of Irish Cobbler is produced in the Daekwanryeong area in fields above 800 meters. The registered and certified seed fields are planted with cut seed but not in tuber units. The fields are sprayed regularly for aphids and are rogued to remove diseased plants. The fields are inspected three times by NAPIO inspectors (Table 2). Potatoes are harvested from fields which pass inspection and placed in temporary field stores. Two weeks to one month later tubers are graded and good tubers are sold to OSPD for subsequent distribution. In 1976, the registered and certified seed distributed by OSPD was stored during the winter by individual farmers.

Storage and distribution procedures will be changed in 1977. Six large potato storage units, a capacity of 2,000 metric tons each, are being built in the Daekwanryeong area by OSPD. Five of the units will be used for certified seed and one for registered seed. Seed potatoes are to be stored during the winter until February or March when they will be sorted out of the stores for disribution to potato farmers. Member organizations of NACF and rural guidance officers of ORD are involved in the distribution of seed potatoes to individual farmers.

Potato certification standards and procedures were revised recently to confirm to planned storage methods (18). Seed potatoes are to be inspected before the harvested tubers are sold by growers to OSPD. The seed potatoes are to be stored by OSPD in the large stores until they are graded out and bagged for distribution. The final seed inspection is to be made by NAPIO officers after bagging (Table 2). Certification tags and seals are to be attached to those bags and containers which contain tubers approved for final certification. Seed lots which do not meet specific certification requirements will be rejected unless regraded.

The seed potato certification program does produce good quality Namjak seed for distribution to Korean farmers. Although the quality of the potato seed is far superior to that used by many farmers in Korea, the specific disease tolerance levels used in seed certification are lower than the standards used in many developed countries. There appears to be considerable room for improving of seed quality.

Changes that could help to improve seed quality

Table 2. Inspection standards for registered and certified seed potatoes in Korea (18).

	Seed grade	
	Registered	Certified
A. *Field inspection*		
Plant growth	Uniform	Uniform
Plant diseases	Maximum percent permitted	
Viruses		
Leaf roll	2.0	2.0
Mosaic	2.5	3.0
Other	1.0	2.0
Total	5.5	7.0
Becteria		
Ring rot	0.0	0.0
Fungi		
Black scurf	1.5	1.5
Fusarium wilt	1.5	1.5
Other wilts	1.5	1.5
Total	4.5	4.5
Other varieties	0.0	0.0
B. *Seed inspection*		
Seed size (grams)	30—250	30—250
Other varieties	0.0	0.0
Diseases		
Ring rot	0.0	0.0
Spindle tuber	0.0	0.0
Other	15.0	20.0
Damaged tubers		
Freeze (soft rot)	0.0	0.0
Mechanical	3.0	4.0
Soil water	10.0	10.0
Insect	1.5	2.0
Sun scald	0.3	0.5
Other tuber defects		
Abnormal shape	0.8	1.5
Hollow heart	5.0	5.0
Break seed	1.0	2.0
Sprouted	3.0	6.0
Foreign matter	1.5	2.0

include: clonal selection, stem cuttings, crop rotation, haulum killing, better sanitation, and earlier roguing and inspection (5). Even though Shimabara has some tolerance to PLRV(1), good seed can not be produced without roguing and inspection. Irrigation, improved plant nutrition, and better management could increase potato yield in seed fields (5).

Adequate support for the seed potato program is needed to maintain present seed quality and to introduce changes which can improve seed quality. A breakdown in sanitation or disease control at any stage can affect seed quality and labor requirements at all subsequent stages of seed production. Hence, an adequate supply of labor and equipment and well trained personnel are necessary to compensate for weather and other factors beyond the control of seed production specialists.

SUPPLY OF CERTIFIED SEED POTATOES

The present volume of certified seed potatoes is not adequate to meet the needs of Korean farmers. The 10,000 MT of certified seed potatoes produced in 1976 to plant the 1977 crop (Table 1) was sufficient, at the recommended planting rate of 1.2 MT/ha, for less than 1/5 of the over 50,000 ha of potatoes grown in Korea. Our observations suggest that certified seed is not distributed uniformly. Instead it goes primarily to the same group of farmers each year. One such group is the farmers who grow spring potatoes in paddies before rice for city markets. Because the growing season is only 70 to 90 days long, profits are good only if potatoes bulk early and yields are high. Consequently, many farmers who grow small fields of potatoes for home consumption apparently do not or can not buy good seed. Their fields commonly have 70 to 95 percent of the plants severely stunted by viruses.

Rural guidance officers and local cooperatives could encourage farmers to use good quality seed potatoes and recommended cultural practices. But, it is unlikely that such a program would be successful until an adequate supply of good seed is available. In many parts of Korea, the spread of aphid transmitted viruses can be rapid (22). Therefore, new seed should be obtained annually from fields in which spread of viruses and other diseases has been successfully controlled. The supply of such seed is much less than the approximately 65,000 MT needed to plant the 1977 potato crop in Korea.

To double or triple the supply of certified seed potatoes, both the seed production area and yields need to be increased greatly. Although arable land in the alpine area is limited, more seed growers could be identified and encouraged to grow certified seed. Already the alpine area probably supplies a significant portion of the noncertified seed used in Korea. New seed areas in the southern part of Korea (5, 22) could be developed. A program for production of certified Shimabara seed should be started in at least one of the new areas. If higher yields are obtained by registered and certified seed growers, only a small increase in the amount of elite seed produced by AES will be required.

DISCUSSION

The certified seed potatoes now produced in Korea are far superior to the seed presently used by many farmers. Yet, further improvements in seed quality can be made by adjusting sanitation and production practices. But, the problem of seed supply is more urgent. The amount of certified seed potatoes produced and distributed needs to be increased by several fold if the projected gains in potato production are to be achieved in the near future.

We believe that 30,000 MT of seed potatoes can be produced if additional seed growers are identified in the alpine area and if new seed production areas are established. In the new seed areas, a functioning program for production of certified grade seed potatoes of autumn crop varieties as Shimabra should be set up. The certification program should include: identification of seed growers having isolated fields, provision of good quality seed, inspection of fields during plant growth, disinfection of equipment as necessary, use of new bags or clean containers, inspection of seed at harvest and after grading, attachment of tags and seals to seed lots which are passed for certification.

More flexibility in Korea's seed potato production program would permit rapid response to changes in varieties, crop protection procedures, transport and storage methods, cultural practice recommendations, farmer requests for seed, and economic factors. For example, when a new variety is approved for distribution to farmers, a 3 or 5 year delay in release may occur because seed is unavailable. This is unacceptable because replacement of Namjak with early bulking and/or disease resistant cultivars is considered a priority item by AES (2) and several consultants (4, 5). Clean seed of promising cultivars should be multiplied at least to the registered seed level prior to final approval for release as a new variety.

Also, the seed program must respond to diseases and other production problems. As seed is now handled, the tubers harvested from several fields can be mixed prior to planting. If a serious disease occurred in one field but was not idenified until the subsequent year, a large portion of one seed class could be rejected. In a flush out system of seed production, this could result in frequent, large yearly fluctuations in seed supply and seed price.

The potato research program should compliment the seed production program. For example, results from disease and insect surveys, estimates of yield loss, data on race stability, and studies of life cycles could be used to make adjustments in seed production procedures necessary to improve seed quality or to avoid potential problems. A partial list of potato diseases and insect pests in Korea has been compiled (11) and a survey of virus diseases (12) and late blight races in Korea has been made (7), but considerable additional pathological and entomological data should be obtained and published to support a growing seed potato certification program.

In order to accelerate and coordinate research on potatoes, the Potato Interdisciplinary Research Committee was formed in 1975 by representatives of the Crop Improvement Research Center, Office of Rural Development and the International Potato Center. The Potato Committee has considered the seed production problems described above as well as many other factors necessary to increase potato production and consumptions. A comprehensive report is being prepared to cover yield constraints, research priorities, equipment needs, and training requirements. Yet, several members of the committee have pointed out that significant yield increases may not be possible without production and distribution of more top quality seed to Korea's farmers.

SUMMARY AND RECOMMENDATIONS

1. An excellent beginning has been made to improve the quality of seed potatoes planted by Korean farmers, but the volume is not sufficient to reach a majority of the potato growers. Production of more seed in the Daekwanryeong area and in other potential seed areas should be encouraged. Since seed production in Korea could be expanded rapidly, certified seed should be imported only if an emergency arises.

2. Key government officers have received the training needed to improve the quality of certified seed. Training of additional government officers, field personnel and farmers in seed production techniques can facilitate production of quality seed and its distribution to farmers.

3. Korea's seed potato certification program operates under a flush out system. Since the response to new disease problems and the distribution of new varieties can be rather slow, provisions for greater flexibility in the seed program should be considered.

4. The Potato Interdisciplinary Research Committee has been formed to accelerate potato research in order to stimulate potato production and consumption in Korea. Hence, this Committee should evaluate recommended changes in seed production procedures and encourage research which could result in production of more top quality seed for Korea's potato growers.

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摘　要

韓國에서 감자의 여러가지 減收要因中 가장 重要한 것은 各種病害인데, 이 가운데에서도 特히 바이러스病인 모자이크病과 잎말림病에 依한 收量減少가 가장 큰것으로 보인다.

韓國에서는 無病 健全한 씨감자를 生産해서 農民에게 普及할 目的으로 1961年에 高冷地試驗場에서 씨감자 檢查事業이 始作되었다. 本論에서는 現在 우리나라에서 生産되고있는 各種의 普及種 씨감자(남작品種)의 生産槪況을 說明하였다. 1976年度에는 大關嶺에 있는 2個 씨감자 生産組合員들에 依해 約 1萬톤 (M/T)의 普及種 남작 씨감자가 生産되어 農水産部의 種子計劃 및 所要를 通해 農民에게 供給되었고, 이들 普及種 씨감자의 檢疫은 國立農産物檢査所 檢査員들이 實施하였다.

普及種 씨감자는 單位收量에 있어서 農民들이 自家採種해서 栽培하는 씨감자를 越等히 능가하지만, 1976年度의 경우 普及種씨감자의 絶對生産量不足으로, 給量은 所要量의 $\frac{1}{5}$에 不過하였다. 한편 秋作用 奬勵品種인 "시마바라"의 普及種은 韓國에서 生産되지 않고 있다.

바이러스病에 걸린 씨감자를 심으면 아무리 肥培管理를 잘해도 收量의 增大는 期待할 수 없다. 따라서 單位收量의 提高는 農民들이 보다 優良한 씨감자를 써야만 이루어 질 수 있으며, 그러기 위해서는 現在 씨감자 供給量을 2~3倍로 增加해야 한다.

現在의 不足되는 普及種 씨감자의 供給量을 充足시키기 위해서는 씨감자의 栽培面積擴大와 씨감자 生産圃場에서의 單位收量增大가 이루어 져야 한다. 韓國는 씨감자生産에 적당한 高冷地가 많이 있으며, 高冷地 以外의 곳에서도 優良한 씨감자는 生産될 수 있다. 優良씨감자의 普及과 栽培法의 改善은 감자의 單位收量을 크게 增大시킬 것이다. 한편 高冷地試驗場에서 生産되고있는 原原種씨감자의 質을 向上시키기위해 근에 개발된 몇가지 새로운 재배기술을 活用해봄직하다. 또한, 無病 健全한 新品種의 씨감자가 신속히 農民에게 普及될 수 있도록 現行 씨감자 檢疫制度는 改善되어야 한다.

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