

6. Exploiting the potential source of genetic diversity of true potato seed (TPS) to obtain new superior potato cultivars¹

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Introduction

Potato is one of the most important crops of the horticultural subsector in Indonesia. Area planted to potato has expanded from 26,000 ha in 1981 to around 65,000 ha in 1998, and the average yield has also increased from around 7 t ha⁻¹ in 1981 to 15.3 t ha⁻¹ in 1998 (Dirjentan Pangan, 1999). In addition, domestic consumption substantially increased from 1.42 kg per capita in 1980 to 3.13 kg per capita in 1984 (BPS, 1984) and to 4.0 kg per capita in 1995 (FAO, 1997 cit. Adiyoga et al., 1999).

Until recently, potato farmers in Indonesia were still dependent on potato seed tubers of Granola, a cultivar imported from Germany and The Netherlands (Potts et al., 1992; Sahat and Asandhi, 1994). Around 80 percent of the current potato area is planted to Granola, mainly due to the lack of cultivars more acceptable to potato farmers in Indonesia.

In order to minimize the importation of potato seed tubers, it is important to obtain a cultivar, which is bred in Indonesia so that it is more adapted to Indonesian conditions. The Research Institute for Vegetables (RIV) (formerly Lembang Horticultural Research Institute = LEHRI) has released the following potato cultivars: Thung; Rapan; Cipanas; and Segunung. However, research surveys conducted in the potato producing areas of West Java indicated that at present farmers no longer use these cultivars (Balithort Lembang and IPB, 1993; Sinung-Basuki, 1996).

There are two approaches that may be taken to obtain superior potato cultivar, (1) short term, by introducing the superior cultivars, clones, and seeds from various crossings, and (2) long term, conducted by conventional crossing method using parent materials introduced from other countries (Sahat and Sunarjono, 1989). Between these procedures, only the long term procedure has already been done by RIV. Obtaining a new potato cultivar using this procedure requires such a long time. For example, Cipanas was released 11 years after it was developed (Sahat and Sunarjono, 1989).

Generally, breeders follow their own criteria in obtaining a new potato cultivar. For example, in the case of Cipanas, the cultivar released by RIV, the breeder wanted to reduce the weaknesses of the previous cultivars (Thung and Rapan) in terms of tuber eye depth and tuber shape (Sahat and Sunarjono, 1989). However, farmers may not consider these criteria as very important compared to tuber yield. The differences in preference of the breeders and the farmers, which does not only happen with potatoes, but also with other commodities such as rice (Maurya, 1989) and faba beans (Ashby et al., 1987), may be the possible factor for non-adoption of the cultivars released by RIV.

The following may be the major constraints in obtaining a superior potato cultivar: (1) the procedure to obtain the superior potato cultivar used by RIV requires a long period, and (2) the cultivars released by RIV were not adopted by farmers due to breeder-farmer differences in preference.

In order to solve this problem, the short-term procedure, especially the introduction of true potato seeds (TPS) from crossing, should be considered as an alternative to obtain a superior potato cultivar. In Indonesia, TPS has been developed as an alternative seed source to the traditional potato seed tuber. Sometimes called botanical seed, TPS is a potential solution to problems associated with the use of seed tubers. Using TPS as planting material in potato production has several advantages, i.e., the cost of the seed may be reduced compared to the traditional seed tuber and it does not transmit

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diseases as much as traditional seed tubers (Sadik, 1983; Wiersema, 1984; CIP, 1987; Umaerus, 1987; Malagamba, 1988).

Research on TPS as an alternative planting material in Indonesia has been conducted either on-station since 1984 (Satjadipura, 1985; 1987; Satjadipura and Sutapradja, 1985; Asandhi and Satjadipura, 1989) or on-farm since 1988 (Sinung-Basuki and Gunadi, 1991; Potts et al., 1990; 1992; Gunadi et al., 1992, Asandhi and Chilver, 1993; Gunadi and Sinung-Basuki, 1993; Sinung-Basuki and Gunadi, 1993; Chilver et al., 1993; 1994). Despite the fact that TPS is recognized in some areas in West Java as an alternative seed source, there are indications that farmers no longer use it. This is probably because TPS progenies introduced in the past had several weaknesses such as variability, either in plant type or tuber type (Sinung-Basuki and Gunadi, 1991; Gunadi, 1994; Sinung-Basuki, 1994; Gunadi and Sinung-Basuki, 1995).

The variability of TPS is considered as a weakness by farmers. However, this variability or genetic diversity also makes it a good potential source of new superior potato cultivars. Variability is indicated in some observations by researchers or farmers, i.e. in a plant population derived from TPS, some plants often have relatively high tuber yields (Sinung-Basuki, 1994). A selected clone from these plants is now a candidate as a superior potato clone. Two candidates for superior potato clones have also been found from a plant population derived from TPS at a demonstration plot in a research project funded by Asian Development Bank (ADB) and coordinated by the International Potato Center (CIP) (Gunadi and Sinung-Basuki, 1999a; 1999b). In the United States of America, true seeds have been used in potato breeding programs for a long time now in order to obtain superior potato cultivars (Howard, 1963).

Research results have indicated that farmers have the capability to select a cultivar that is appropriate to their own needs (Ashby et al., 1987; Maurya, 1989). Therefore, in order to increase the number of farmers who adopt a potato cultivar, they need to be active participants in the research process (farmer participatory research). Through this, a potato cultivar would have a better chance of meeting the farmer's needs and consequently reducing dependence on imported potato seed tubers.

Objectives

Immediate objectives

1. To select plants derived from TPS as potential sources of superior clones
2. To identify two superior potato clones from selected plants
3. To obtain information on the criteria used by potato farmers to identify a superior potato clone

Long-term objectives

1. To obtain new superior potato cultivar(s), acceptable to farmers and appropriate to the conditions in Indonesia by exploiting the potential source of genetic diversity of true potato seeds (TPS)
2. To determine a methodology in obtaining new superior potato cultivars wherein farmers are active participants (farmer participatory research)
3. To minimize dependence on imported superior potato seed tubers by obtaining new superior potato cultivar(s).

Expected Output

First year (2001)

- Two superior clones selected either by farmers or researchers
- Criteria used by potato farmers to identify a superior potato clone

Second year (2002)

- Seed tubers of the two superior potato clones which are free from virus and diseases that will be tested through planting trials
- Description of the two superior potato clones selected either by farmers or researchers
- Information on plant response of superior potato clones to fertilizers, resistance to potato pests and diseases, and information on their tuber quality, whether it is for consumption or for processing

Third year (2003)

- Two new superior potato clones which are acceptable to farmers and appropriate to conditions in Indonesia
- Information to complete the description of new superior potato clones

Research Methodology for Selection of Superior Clones from TPS

This activity was a field experiment conducted by researchers and farmers at a farmer's field in a potato producing area in Pangalengan, West Java, between May and September, 2001.

Ten TPS progenies were used in this research activity (Table 1). These TPS progenies were selected from the progenies at the International Potato Center (CIP), with most having been evaluated either on station or on-farm and found to have the potential to produce superior potato cultivars. The ten TPS progenies as treatments were grown in plots which were arranged in a Randomized Complete Block Design, with each treatment replicated four times. The experimental unit consisted of 8 rows with 20 plants per row, bringing the total number of plants in each plot to 160. In addition, two TPS progenies, i.e., HPS 7/67 and MF-II x TPS-67, which totaled 1500 plants and 1600 plants, respectively, were planted beside the experimental plots. The total number of plants derived from TPS was 9500.

Prior to transplanting, animal manure was applied at the base of each furrow at 30 t ha⁻¹, ammonium sulphate (AS) and super phosphate (SP36) at a rate of 165 kg N and 360 kg P₂O₅ ha⁻¹, respectively. AS at a rate of 65 kg N ha⁻¹ was applied as a top dressing at the first hilling-up, i.e. 25 days after transplanting (DAT) while the second hilling-up was done at 40 DAT. Manual weeding was done just before the first and second hilling-up. Plants were sprayed with Mancozeb regularly during the growing season to control late blight (*Phytophthora infestans*) and Profenofos to control insect pests, such as thrips and aphids.

In this activity, farmer-participants were identified who had several years of experience in planting potato to actively involved in the research process. Locations easily accessible to participating farmers were selected for the trials in order to make the active participation of farmers in the trials easier. The farmers were invited to a planning meeting to explain the research to them. In the meeting, the importance of active participation and involvement of the farmers in the research activity was also explained. Fifteen farmers from six villages in Pangalengan and five extension workers attended the planning meeting.

The same group of farmers was invited to a second meeting conducted in the experimental fields at 63 DAT. This time, 11 farmers from six villages in Pangalengan and five extension workers attended the meeting.

In the field, the farmers were asked to select the potato plant(s), which they judged were superior in terms of growth from amongst the 9500 plants. Each farmer was asked to select only two superior potato clones. Meanwhile, researchers also selected individual plants with the criteria used in the previous research (Kusumo, 1984; Soetiarso, 1993; Sinung-Basuki, 1996). After the farmers finished selecting, they were also asked to answer a questionnaire concerning the criteria used to select superior potato clones.

The farmer-participants were invited to a third meeting at the experimental field at harvest time. Harvest for research activity (1) was done during the second week of September 2001 with the potato plants derived from TPS. This was at 118 days after transplanting. Harvest was done per individual hill so that the farmers could evaluate the potato plants individually in terms of the quantity of harvest. The number of farmers who attended increased to 16 while six extension workers also participated. The farmers were again asked to select two individual potato plants harvested based on the quantity and shape of tubers, after which they were again asked to describe the criteria that they used.

Results and Discussion

In general, the farmers were very eager to be involved in the research because it was a new idea for most of them. Farmers in the past were treated as clients who were there only to receive the research results and not to be actively involved in the research process.

The farmers used the following criteria to select the superior potato clones at 63 DAP: relatively big stem diameter (\pm 1 cm); moderate plant height (\pm 50 cm); erect plant type that does not easily fall down; broad leaves with strong green color; limited number of stems; and resistance to pests and diseases, especially late blight. Additional criteria used by farmers to select superior potato clone during its vegetative stage were the following: hairy leaves; and short-growing period (i.e., whether it could be harvested at \pm 85 DAP)

At harvest time, the following criteria were used by farmers to select the superior potato: many tubers ($>$ 10 tubers) of big size; preferably round-shaped tubers (like Granola), tolerance to bacterial wilt; strong skin and yellow color; and moderate number of stolon with short length.

This research suggests that the farmers could become partners in the research process and not only clients who just receive research results. In this way, important information that could be obtained directly from the farmers are not anymore ignored. Their involvement and participation in the research process will increase the number of farmers who will adopt a potato cultivar. Through farmer participatory research, the farmers' preferences would be taken into account in identifying a cultivar that they will use in their potato production system.

Mean tuber yields of ten TPS progenies at harvest, grown in Pangalengan in research activity (1) is presented in Table 2. Tuber yields were comparable to yield from the seedling transplants in previous research results. The number of plants harvested was only 80 percent due to the dry climate during the initial growing period. Although the field plots were irrigated every two days, many of the potato plants derived from TPS died and replanting had to be done. Potato derived from TPS, especially seedling transplants, were very sensitive to dry conditions.

Although mean tuber yield in the trials was relatively low at 7.2 ton ha⁻¹ (Table 2) compared to the tuber yield of potato grown from tubers, from the plant population of 9500 plants, 33 individual plants were selected as superior potato clones. The tuber yield of these clones ranged from 0.5 kg to 2.0 kg per plant. This indicates that TPS is a potential source of new superior potato clones. The variability of TPS is considered as a weakness by farmers, but its genetic diversity shows that it could be a potential source to obtain new superior potato cultivars. This was indicated in the observations of both the researchers and farmers that in a plant population derived from TPS, individual plants were found to have

relatively high tuber yields (Sinung-Basuki, 1994). The clones selected from the experiment have become candidates for identification as superior potato clone. Two candidates for superior potato clones have been found from a plant population derived from TPS at a demonstration plot in a research project funded by Asian Development Bank (ADB) and coordinated by International Potato Center (CIP) (Gunadi and Sinung-Basuki, 1999a; 1999b).

The 33 clones selected in the research activity (1) will be used in subsequent trials with farmers and researchers to identify two superior potato clones.

Conclusion

From the research conducted in 2001, the following may be concluded:

- a. True potato seed (TPS) is a potential source for obtaining a superior potato clone.
- b. Farmers who are actively involved in the research process and not only as clients-receipients of research results could become research partners.
- c. From 9500 potato plants derived from TPS, 33 individual plants have been selected by farmers or researchers as superior potato clones.
- d. The criteria used by farmers to select superior potato either at the growing period or at harvest were described.

Future Research Activities

Selection of superior clones (2002)

Rhe TPS minitubers from the 33 selected plants will be planted in a farmer's field and the methodology used above will be repeated to identify two superior clones.

Multiplication of seed tubers derived from superior clones and their description (2002)

A Rapid Multiplication Technique (RMT) will be used at RIV to multiply the two superior clones selected from the previous experiment. This will produce healthy seed for subsequent evaluations described below.. In addition, description of the two superior clones will be made.

Study plant response to fertilizer especially to macronutrients N, P and K (2002)

Plant response to fertilizers, especially to macronutrients N, P and K, will be studied at a farmer's field in a potato producing area in Pangalengan, West Java. Different amounts of fertilizers, based on the result of soil analysis will be the treatments.

Study plant resistance to late blight (*Phytophthora infestans*) (2002)

Plant resistance to late blight (*Phytophthora infestans*) will be conducted at the RIV experimental field. In order to measure plant resistance to late blight, the International Potato Center (CIP) recommends the area under the disease progress curve (AUDPC). The AUDPC is a resistance parameter calculated from the percentages of leaf area affected estimated at different times during an epidemic.

Study plant resistance to bacterial wilt (*Ralstonia solanacearum*) (2002)

This study will also be conducted at the experimental field at RIV. Observation will be conducted on the degree of wilt for each plant at 15-day intervals for two months starting 45 DAP and continuing until 15 days before harvest using the CIP scale of 1 to 5 (1 = 0%; 2 = 1-25%; 3 = 26-50%; 4 = 51-75%; and 5 = 76-100% of the plant is wilted).

Evaluation of tubers produced from the superior clones (2002)

Evaluation of tuber quality according to their dry matter content, specific gravity, sugar, carbohydrate, and solanine contents will be conducted at the postharvest laboratory in RIV, Lembang. This evaluation aims to obtain information on the tuber quality of the superior clones selected, and classify whether the tubers are for consumption or for processing.

Multi-location trials of the superior clones selected in rainy and dry seasons (2003)

Multi-location trials will be conducted mainly at the potato production center in West Java, Central Java, and East Java, both during the rainy and dry seasons. Granola, the common cultivar grown by the farmers will be used as a control. At each location, three farmers will be asked to grow the two superior clones using their own methods.

At the end of the third year, two new superior potato clones appropriate for the farmers' needs will finally be identified. Adoption of these clones is expected to be high and should be sustainable because of the element of farmer participation in selection.

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Table 1. Ten TPS progenies and their CIP number used in research activity (1), Pangalengan, April 2001

No	CIP Number	Progeny name
1	IP88006	HPS 7/67
2	IP88004	MF-II x TPS-67
3	994002	Atzimba x TPS-67
4	994014	LT-8 x TPS-67
5	IP88010	TPS-2 x TPS-67
6	IP88008	TPS-25 x TPS-67
7	996003	Achirana x TPS-67
8	994015	Serrana x TPS-13
9	980001	Serrana x DTO-28
10	994016	Serrana x TPS-67

Table 2. Mean tuber yields at harvest of ten TPS progenies in Pangalengan, September 2001

Progeny	CIP No.	% plant harvested	Yield per plot (kg. 36 m ²)	Yield per ha (ton. ha ⁻¹)
HPS 7/67	IP88006	74.4	40.5	11.2
MF-II x TPS-67	IP88004	77.6	43.0	11.9
Atzimba x TPS-67	994002	67.6	19.4	5.4
LT-8 x TPS-67	994014	68.6	22.7	6.3
TPS-2 x TPS-67	IP88010	75.8	31.7	8.8
TPS-25 x TPS-67	IP88008	66.1	31.5	8.7
Achirana x TPS-67	996003	55.5	16.2	4.5
Serrana x TPS-13	994015	53.6	14.8	4.1
Serrana x DTO-28	980001	57.3	16.4	4.5
Serrana x TPS-67	994016	67.8	24.5	6.8
Mean		66.4	26.1	7.2
LSD 5%		17.3	8.2	2.3
CV (%)		17.9	21.6	21.6

Note: LSD = Least Significant Difference; CV = Coefficient of variation