

Participatory Plant Breeding

Potato Selection Manual

What is participatory plant breeding (PPB)?

PPB is a collaboration between plant breeders and farmers that aims to develop cultivars relevant to farmer's needs. The main difference between a participatory and conventional breeding program is that in PPB most of the early selection takes place by farmers on farms rather than by breeders on research stations.

Genetic diversity

Farmer participatory breeding works best when we start with a diverse population of tubers created by crossing distant parents. In our program, this process is overseen by Dr. Duane Falk in Ontario. Duane is a plant breeder, recently retired from the University of Guelph. He conducts his work on his research farm in southern Ontario. Duane selects the female parent and allows that plant to freely cross pollinate with various plants. See Table 1 for a description of the potato populations available for the 2016 planting season. The harvested seed is planted in a greenhouse (Figure 1), and the mini-tubers harvested from the greenhouse plants are then planted in the field. The resulting tubers are distributed to participating farmers. Duane started this process in 2014 and the first tubers for on-farm testing from his program will be made available in 2016. Additional populations will be available in 2017.



Figure 1. Potato plants grown from seed (left) and mini-tubers harvested from a Chieftain cross (right).

Table 1. Description of potato populations available for 2016 planting season.

Female parent	Year of release	Source	Skin colour	Flesh colour	Disease Resistance	Comments
<i>Red skinned female parents</i>						
U of G bulk						Bulk of a number of types and colours
Ruby Gold	1987	Univ. of Guelph	red	yellow		Early, medium size, good taste
Chieftian	1966	USDA	red	white	tolerant to scab, late blight	Medium maturity, reliable, good storage
Gundega	2011	Priekuli, Latvia	red	yellow	tolerant to scab, late blight	medium-late maturity, high starch
Magdalena	2002	Priekuli, Latvia	pink	yellow	tolerant to scab, late blight	medium-late maturity
<i>Yellow and white skinned female parents</i>						
Yukon Gold	1981	U Guelph	yellow	yellow		early-medium maturity, large tubers, popular with consumers
Atlantic	1978	USDA	white	light yellow	tolerant to scab	medium maturity, good storage, good weed competition
Sapphire		Netherlands	yellow	yellow	tolerant to scab, late blight	medium-late maturity, large tubers
Jacqueline Lee	2001	Mich. State Univ.	yellow	yellow	good resistance to late blight, scab	medium-late maturity, good storage
Imanta	2008	Priekuli, Latvia	yellow, pink eye	light yellow	tolerant to scab, late blight	medium-late maturity, high starch
Nicolet	2010	Univ. of Wisc.	white	white		medium-late maturity, good storage, low glycoalkaloids
Monta (Y)	2003	Priekuli, Latvia	yellow	yellow	tolerant to scab, late blight	early maturity, good weed competition
<i>Blue skinned female parent</i>						
Adirondack Blue	2003	Cornell Univ.	blue	blue	tolerant to scab	short storage, high anthocyanins

Population selection

The 13 crosses have been grouped based on tuber colour, and further broken down into three sets/group for a total of 8 sets (Table 2). The number of tubers received will vary depending on if you would like to receive one tuber from each hill that produced tubers (total diversity), tubers from only the high yielding hills (higher yielding hills), or a bulk set of tubers (bulk). While the tubers have been classified according to the predominant colour of the female parents, there will be some colour variation within each group.

Table 2. Female parent, tuber colour of offspring, number of tubers from the cross in each set, and total number of tubers in each set.

Female Parent	Colour of female parent (skin/flesh)	Tubers/cross		
		Total diversity ¹	Higher yielding hills ²	Bulk ³
Group 1		Set 1	Set 2	Set 3
U of Guelph	red/yellow	17	14	
Ruby Gold	red/yellow	35	20	
Chieftian	red/white	38	21	
Gundega	red/yellow	4	4	
Magdalena	red/yellow	10	9	
<i>Tubers/set</i>		<i>104</i>	<i>68</i>	<i>20</i>
Group 2		Set 4	Set 5	Set 6
Yukon Gold	Yellow/white	38	20	
Atlantic	White/yellow	22	17	
Sapphire	Yellow/yellow	4	2	
Jacqueline Lee	Yellow/yellow	11	7	
Imanta	Yellow/yellow	7	6	
Nicolet	White/white	14	10	
Monta	Yellow/yellow	9	9	
<i>Tubers/set</i>		<i>105</i>	<i>71</i>	<i>23</i>
Group 3		Set 7	Set 8	
Adirondack Blue	blue/blue	30	15	

¹This set contains one tuber from each of the seedlings grown from the outcrossed true potato seed (TPS).

²This set contains one tuber from each of the seedlings grown from the outcrossed true potato seed (TPS) that produced more than 3 tubers.

³This set contains one tuber from each of the seedlings grown from the outcrossed true potato seed (TPS) that produced more than 10 tubers.

Implementation of the trial

Location – The tubers should be planted in an area representative of the conditions where you would normally grow potatoes. Ideally, your potato populations should be grown under normal management practices in part of a potato field.

Planting – Each farm will receive a set of 15-100 tubers, depending on the set chosen. All tubers are genetically unique as they were each harvested from different hills that originated from different outcrossed seed. Within the row the tubers should be planted a bit further apart than you would typically plant potatoes to ensure that each hill can be dug separately at harvest.

Each population within the set will be bagged separately with the female parent indicated on the bag. If desired, the populations can be kept separate during planting and the start of each population can be marked with a stake or a flag. Throughout the selection process individual clones can be tracked, and clones can be identified by the name of the female parent and hill number. For example, in the first year of selection the fourth hill planted of the Ruby Gold population could be marked Ruby Gold-4. If you are tracking individual clones this system should be used throughout the years of on-farm selection, and for ease of identification the hill or plot number can be added in each year.

Selection

Selections will be made a few times during the growing season, typically after flowering, closer to maturity, and after harvest. Selections will be made based on agronomic characteristics (plant vigour, disease and insect resistance, maturity), yield potential, and tuber appearance.

Prior to starting this project it is a good idea to think about the characteristics that are most important to you. It may not be practical to select for all of these characteristics in every year, but it is a good idea to keep in mind what you are looking for in a potato. Characteristics you may want to select for include:

- Early season vigour
- Disease resistance
- Insect resistance
- Maturity
- Skin colour
- Tuber size
- Yield
- Storability

All of the tubers from the selected hills will be harvested in 2016 and stored on-farm for planting in 2017. Selections may also be made prior to planting in 2017 for storability.

Year 1 of on-farm selection

Farmer participants will receive a set of tubers based on their colour preferences (Table 2). There are three basic sets of tubers: red, yellow/white, and blue. While the colour of tubers from each set is generally known, there will be some variation. In the first year it is expected that approximately 20% of the hills will be selected to move forward to the next generation. All tubers from each of the selected hills will be saved on farm for planting the following spring.

Year 2 of on-farm selection

Four tubers from each selected hill will be planted as a unit, separated by an empty space to avoid a mix-up at harvest time. Selection in year 2 will remove approximately 50% of the tuber units. The tuber units will be selected or discarded as a whole. Depending on the size of the set that you started out with, the diversity within your set, and how strict you are being with your selections, approximately 2 - 10 tuber units/set will be stored on-farm for planting the following year.

Year 3 of on-farm selection

Tubers harvested from each of the selected tuber units will be planted in larger plots to allow for yield assessment and grading.

Year 4 of on-farm selection

Continued evaluation of selected clones on-farm. Farmer selected clones will also be assessed at a research farm and compared to check varieties where traits such as emergence, vigour, maturity, disease resistance, tuber morphology, defects and yields will be measured.

