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Selection of Individual Tubers in Potato Breeding

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Summary. Out of 720 field-grown potato first year seedlings plants with best tuber apearance and large and medium size tubers with best shape were respectively selected. The tuber progeny of each group was evaluated in field experiments. It was demonstrated that the selection of individual tubers was very effective in the elimination of clones with irregular tuber shape and deep eyes. The tuber progeny of selected tubers was not inferior to the tuber progeny of selected plants. Possible applications of the results to practical potato breeding are discussed.

Key words: Potato – Breeding – Selection methods

Introduction

It is usual in potato breeding to grow first year seedlings in pots. One to three small tubers produced in this way are planted to obtain the first tuber progeny.

The selection among first year seedlings grown in pots is not very efficient (Domański and Świeżyński 1976; Howard 1963; Krug et al. 1974; Niopek 1967). The same is true for the selection among clones grown in the first clonal generation (Davies and Johnson 1974). This is a major difficulty in potato breeding. A large number of clones must be handled individually for 2 years (first year seedlings and their progeny) with little chance of being properly evaluated. Within this period the number of clones is usually reduced to 2-10% of the initial number (Howard 1963, Roguski et al. 1965; Ross 1970) because handling of a large number of clones is not practical. It is likely that in this way many valuable clones are lost (Rundfeldt 1970).

The question arises: Is it possible to retain a larger number of clones for further analysis without excessive labor or make a more efficient selection in the first breeding stages?

It was demonstrated in previous work (Świeżyński 1965, 1971) that selection of individual tubers with high starch content and good tuber shape is an efficient method of selecting better clones for the breeding of potatoes with increased starch content. It was decided, therefore, to obtain more information about the efficiency of this way of selection.

In the present paper the selection of individual tubers is compared with the selection of individual plants. The starch content was not evaluated in this material.

Materials and Methods

In 1976, from each of 3 progenies originating from breeding lines of good table quality: B 5560 × M 60555 (A), PK 44/65/1 × M 60292 (B) and PG 341 × PK 1211 (C), 2 replications of 120 plants = 240first year seedlings were grown in the field, spaced 60 × 60 cm (Table 1).

The vegetative period of each plant was determined in days, beginning with May 20th, the date of planting in the field. The following were harvested from each progeny:

a 60 plants with best tuber general appearance (BP). In their selection regularity of tuber shape, depth of eyes, tuber size and tuber yield have been taken mainly into account.

b 60 plants rated as second best (SP)

c All the remaining plants (RP). There should be 120 of each progeny but because of plant losses during vegetation, there were only 112-116 plants.

The tuber yield of each plant was evaluated as follows:

1. Weight of tuber yield (g)
2. Tuber number. By dividing tuber weight by their number the mean tuber weight was obtained (g)
3. Regularity of shape. Score: 1 (worst) – 9 (best)
4. Depth of eyes. Score: 1 (deep) – 9 (shallow)
5. Second growth. Score: 1 (many tubers with pronounced second growth) – 9 (no second growth)
6. Homogeneity of tuber size. Score: 1 (big and small tubers in one plant) – 9 (all tubers of the same size)

From each plant 2 medium-size tubers were saved as a representative sample of BP, SP and RP. It was attempted to choose tubers weighing 50-70 g each.

All the remaining tubers from each progeny were mixed to-

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gether and out of the mixture were taken: 1) all tubers of a diameter greater than 50 mm – big tubers and 2) all tubers with a diameter between 30 and 50 mm – medium size tubers.

Among big and medium size tubers the best ones were selected. The main selection criteria were: regularity of tuber shape, depth of eyes and luck of second growth. Too elongated tubers were also avoided.

From each progeny the tubers were selected in this way:

1) 30 best big tubers (BBT)
2) 60 best medium size tubers (BMT)
3) 60 second best medium size tubers (SMT)

Only from progeny B were no BBT selected because too few big tubers were found (Table 1).

On each selected tuber the following were determined: 1) weight (g), 2) regularity of tuber shape (score: 1-9), 3) depth of eyes (score: 1-9) and 4) second growth (score: 1-9).

In 1977 the tuber progeny from the above material was grown from pre-sprouted seeds planted on the 20th of April. Randomised plots of 2 rows × 15 plants = 30 plants in 4 replications were used. The spacing was in 2 replications: 62.5 × 40 cm and in the remaining ones, 62.5 × 80 cm.

In this way each group of plants, from each progeny, consisted of 30 × 4 = 120 plants.

In BP and SP, 2 tubers were planted from each of 60 plants = 120.

In RP, which were more numerous, 120 tubers were selected for planting. The damaged ones and those deviating from seed size were eliminated.

In BMT and SMT each plot consisted of 1 row of 15 plants from BMT and 1 row of 15 plants from SMT. Sixty BMT + 60 SMT from each progeny produced 1 group of 120 plants.

In BBT each tuber was cut into halves and each half was planted at a different spacing. As tubers from 2 progenies only were available within each replication, on each plot 15 plants (one row) from each progeny were grown. In this way one group of 120 plants was obtained from BBT of 2 progenies (30 × 2 × 2).

The weight of seed pieces within each group was determined (Table 1).

In 1977, during the vegetative period, many plants with secondary virus symptoms were found. There was also a heavy infection with *Phytophthora infestans*. Both factors accelerated the death of the plants. The vegetative period was determined in days counting from the planting date.

At harvest time all the plants were lifted individually and evaluated in the field, as practised in the breeding work. In their evaluation the main considerations were: regularity of tuber shape,

Table 1. Characteristics of the analysed materials

				Progeny			Total
				A	B	C	
	Number of plants grown			240	240	240	720
	number of plants with no tuber yield			4	7	8	19
First	number	BP		60	60	60	180
year	of	SP		60	60	60	180
seedlings	selected	RP		116	113	112	341
		BT		278	45	162	485
		MT		1934	1476	1685	5095
Tuber	Mean weight	BP		82	68	85	79
progeny	of seed tubers (g)	SP		75	53	70	66
		RP		76	45	66	62
		BBT*		63	–	74	68
		BMT		65	53	71	63
		SMT		68	49	61	59
	Number of plants	BP	a	120	120	120	360
	originating from:		b	104	74	101	279
		SP	a	120	120	120	360
			b	96	73	93	262
		PR	a	120	120	120	360
			b	88	62	91	241
		BBT	a	60	–	60	120
			b	51	–	48	99
		BMT	a	60	60	60	180
			b	55	40	53	148
		SMT	a	60	60	60	180
			b	53	37	49	139
	Total number of plants in		a	540	480	540	1560
	the tuber progeny		b	447	286	435	1168

* half tubers
a = total number planted
b = number of plants which produced a tuber yield of not less than 200 g

depth of eyes, tuber size and tuber yield. It was decided to choose in this way about 20% advantageous plants, not taking into account any previous information about them. Afterwards, the yield of each plant was collected separately and described in the same way as the yield of first year seedlings.

Because of severe virus and *Phytophthora* infection, nearly 25% of plants produced a tuber yield less than 200 g (Table 1). These plants were eliminated from analysis. It was resigned also from the analysis of the influence of spacing on plant characteristics.

The position in the field of plants originating from individual selected tubers was known. This made it possible to correlate individual characters in the selected tubers and in their progeny.

Results

Differences between Progenies, Groups of Selected Plants and Groups of Selected Tubers

Mean values of first year seedlings and of all types of their tuber progenies are presented in Table 2.

Most of the differences between the mean values of individual progenies in tuber quality were found to have the same direction in first year seedlings and in all groups of their tuber progenies. For instance: progeny A was better than progeny B in tuber size and number of advantageous plants. On the other hand, progeny B was better than progeny A in the regularity of tuber shape and low extent of second growth.

In the length of vegetative period and in tuber yield this regularity was not found. First year seedlings of progeny B produced a lower tuber yield and had a shorter vegetative period than those of the progeny C. In the tuber progeny both progenies had a similar vegetative period and produced a similar tuber yield.

In most analysed characters, the division of first year seedlings into 3 groups: BP, SP and RP was successful. The mean values of the tuber progenies of BP in each of the 3 progenies were the best and those of RP were poorest in: 1) tuber yield, 2) tuber size, 3) number of advantageous plants, 4) regularity of tuber shape, 5) depth of eyes and 6) second growth. Some inconsistancy among progenies was found in homogeneity of tuber size. However, in general the tuber progeny of BP received a higher score here also.

The selection of the various groups of advantageous tubers (BBT, BMT and SMT) was successful. The progeny of BBT produced much larger tubers (the mean tuber weight of the progeny of BBT was 81 g and that of the progenies of BMT and SMT – respectively 59 g and 57 g). In most characters (number of advantageous plants, regularity of tuber shape, depth of eyes and second growth)

Table 2. Comparison of mean values of various selections

		Mean tuber yield (g/hill)				Mean tuber weight (g)				Number of advantageous plants selected				Mean length of vegetative period (days)			
		progeny				progeny				progeny				progeny			
		A	B	C	mean	A	B	C	mean	A	B	C	total	A	B	C	mean
First year seedlings		671	534	639	615	38	24	36	32	–	–	–	–	146	135	152	145
Tuber	BP	802	602	587	671	66	49	53	57	17	12	14	43	115	109	105	110
progeny	SP	776	549	584	645	58	34	50	48	6	2	8	16	115	106	106	109
of	RP	684	497	482	560	51	31	46	43	7	1	3	11	111	106	106	108
	BBT	766	–	588	680	84	–	77	81	10	–	8	18	119	–	105	112
	BMT	784	712	545	679	74	48	56	59	13	6	10	29	115	111	106	111
	SMT	831	564	463	630	70	42	56	57	6	2	4	12	115	107	105	100
		Regularity of tuber shape: score: 1 (worst) – 9 (best)				Depth of eyes: score: 1 (deep) – 9 (shallow)				Second growth in tubers: score: 1 (extensive) – 9 (no)				Homogeneity of tuber size: score: 1 (no) – 9 (extreme)			
		progeny				progeny				progeny				progeny			
		A	B	C	mean	A	B	C	mean	A	B	C	mean	A	B	C	mean
First year seedlings		6.4	6.7	6.6	6.6	6.2	6.4	6.4	6.4	6.4	6.7	6.8	6.6	5.9	6.3	6.2	6.2
Tuber	BP	6.7	7.2	7.1	7.0	6.8	6.8	7.0	6.9	6.8	7.4	7.2	7.1	6.7	6.6	6.5	6.6
progeny	SP	6.0	6.5	6.6	6.4	6.1	6.3	6.6	6.4	6.5	6.8	7.2	6.8	6.2	5.7	6.3	6.1
of	RP	5.7	6.3	6.0	6.0	5.7	5.8	6.2	5.9	6.4	6.6	6.8	6.6	6.1	6.1	6.2	6.1
	BBT	6.9	–	6.9	6.9	6.7	–	6.9	6.8	6.8	–	7.5	7.1	6.9	–	7.3	7.1
	BMT	7.2	7.6	7.2	7.3	7.0	7.2	6.9	7.0	7.1	7.2	7.4	7.2	7.0	6.2	6.4	6.6
	SMT	6.6	6.9	6.7	6.7	6.5	6.5	6.7	6.6	6.4	7.2	7.4	7.0	6.5	6.5	6.4	6.5

the progeny of BBT was intermediate between the progenies of BMT and SMT. In tuber yield and in homogeneity of tuber size the differences between groups of selected tubers were rather small and inconsistent.

No large differences in vegetative period were found between various types of tuber progenies.

Comparision of Tuber Progenies of Selected Plants with Tuber Progenies of Selected Tubers

In general, the progenies of selected tubers from all groups were similar to the progenies of GP and better than the progenies of RP. This was found for: 1) tuber yield, 2) tuber size, 3) number of advantageous hills, 4) regularity of tuber shape, 5) depth of eyes, 6) second growth and even in, 7) homogeneity of tuber size.

In tuber size, the progeny of BBT was much better than the progeny of BP.

If the number of advantageous plants is related to the number of plants growing in tuber progenies (Tables 1 and 2), out of 360 plants originating from BP – 43 advantageous ones were selected and out of 300 plants originating from BBT + BMT – 18 + 29 = 47 advantageous ones were selected. These results indicate that selection of individual tubers was slightly more efficient.

Table 3. Regularity of tuber shape in first year seedlings and in their tuber progeny

First year seedlings		Tuber progeny						
Group	Tuber shape score	Number of plants with tuber shape score					Total	Mean value
		5	6	7	8	9		
BBT	9			8	5		13	7.4
	8		3	16	10	1	30	7.3
	7	1	14	19	5		39	6.7
	6	2	10	4	1		17	6.2
BMT	9		2	15	15	3	35	7.5
	8		16	28	25	7	76	7.3
	7		9	23	4	1	37	6.9
BBT + BMT		3	54	113	65	12	247	7.1
BP		10	62	142	55	10	279	7.0

BBT = best big tubers
BMT = best medium size tubers
BP = best plants
score: 1 (worst) – 9 (best)

Table 4. Depth of eyes in first year seedlings and in their tuber progeny

First year seedlings		Tuber progeny						
Group	Depth of eyes score	Number of plants with depth of eyes score					Total	Mean value
		5	6	7	8	9		
BBT	8		4	17	8	1	30	7.2
	7	1	12	31	6		50	6.8
	6	2	13	2			17	6.0
	5		1	1			2	6.5
BMT	9			2	6	3	11	8.1
	8		11	37	18	2	68	7.2
	7	3	16	34	7		60	6.8
	6		4	5			9	6.6
BBT + BMT		6	61	129	45	6	247	6.9
BP		11	77	140	46	5	279	6.8

Table 5. Extent of second growth in first year seedlings and in their tuber progeny

First year seedlings		Tuber progeny									
Group	Second growth score	Number of plants with second growth score								Total	Mean value
		2	3	4	5	6	7	8	9		
	9	1		1	2	5	4	12	3	28	7.0
	8				1	1	2	2		6	6.8
BBT	7	1		2	3	8	13	11	8	46	7.0
	6			1		2	3	7	4	17	7.6
	5					1	1			2	6.5
	9			2	2	14	20	21	15	74	7.4
	8		2	1	1	4	6	9	5	28	7.1
BMT	7				4	7	4	11	5	31	7.2
	6		1		1	2	4	3	3	14	7.1
	5						1			1	7.0
BBT + BMT		2	3	7	14	44	58	76	43	247	7.2
BP		1	2	7	24	55	77	71	42	279	7.1

Table 6. Values of the correlation coefficients between characteristics of selected tubers and of their tuber progenies

Character	Group	Correlation coefficient
Regularity of tuber shape	BBT	0.50
	BMT	0.26
Depth of eyes	BBT	0.49
	BMT	0.43
Extent of second growth	BBT	−0.07
	BMT	0.07

BBT = best big tubers
BMT= best medium size tubers

Relationships between Morphological Characters of Individual Tubers and their Tuber Progenies

Regularity of tuber shape (Table 3), depth of eyes (Table 4) and extent of second growth (Table 5) were analysed. The scores given to individual selected tubers and to their tuber progenies are compared in BBT and BMT and respective values of the correlation coefficients are given in Table 6. Additionally, in Tables 3-5, the summarised scores of the tuber progenies of BBT + BMT are compared with summarised scores of the tuber progenies of BP.

A positive correlation was found between selected tubers and their tuber progenies in regularity of tuber shape and depth of eyes. No correlation was found in the extent of second growth. In regularity of tuber shape the value of the correlation coefficient was higher for BBT ($r = 0.50$) than BMT ($r = 0.26$), the difference being significant at the $p = 0.05$ level.

Relationships between Regularity of Tuber Shape (Table 7), Depth of Eyes (Table 8), Extent of Second Growth (Table 9) and Homogeneity of Tuber Size (Table 10), respectively, and Tuber Yield in BP, RP and their Tuber Progenies

Only a weak correlation was found between tuber yield and all of these four characters. All the five characters were used as selection criteria. First year seedlings included into BP were usually rated in regularity of tuber shape and depth of eyes at not less than 6, in second growth and homogeneity of tuber size at not less than 5. Most of them produced a tuber yield of not less than 400 g.

The selection was effective in the regularity of tuber shape and depth of eyes (in the tuber progeny of BP, plants rated less than 6 were rare) but it was only slightly effective in extent of second growth and homogeneity of tuber size only small differences being found between progenies of BP and progenies of RP. The effect of selection for tuber yield was evident in the increased frequency of high yielding plants.

Correlation between Characters in First Year Seedlings and in Selected Tubers (Table 11).

In the phenotypic variation of individual plants within first year seedlings, most extensively correlated were the regularity of tuber shape and the depth of eyes; plants with more regular tuber shape tending to have tubers with less deep eyes ($r = +0.60$ to $r = +0.72$). Less extensively correlated was the second growth, both with the regu-

Table 7. Correlations between tuber yield and regularity of tuber shape in first year seedlings and in their tuber progeny

Tuber yield (g)	First year seedlings							Tuber progeny						
								Best plants (BP)						
over 1400				2	2					2	9	1	6	
1200 – 1399			1	5	5	3				1	2	3	3	2
1000 – 1199				5	15	4				2	6	10	6	1
800 – 999			1	4	18	16	1			1	10	17	3	
600 – 799				14	23	9					8	23	10	1
400 – 599				5	23	9				3	19	27	10	2
200 – 399				4	9	1				1	16	54	16	4
0 – 199				1						not analysed				
								Remaining plants (RP)						
over 1400			2							1	4	1		
1200 – 1399				1	1			1	1	1	5	1		
1000 – 1199			3	3	2	1				1	7	9		
800 – 999			7	12	11			1	1	2	6	4	1	
600 – 799		4	8	24	20	7			3	6	14	13	2	
400 – 599	1		9	31	35	4		1	2	13	29	13		
200 – 399		2	11	35	35	10		3	4	20	41	26	4	
0 – 199		2	7	26	22	5				not analysed				
	3	4	5	6	7	8	9	3	4	5	6	7	8	9

Regularity of tuber shape: score 1 (worst) – 9 (best)

Table 8. Correlations between tuber yield and depth of eyes in first year seedlings and in their tuber progeny

Tuber yield (g)	First year seedlings						Tuber progeny							
							Best plants (BP)							
over 1400			4	1	1					1	7	8	1	1
1200 – 1399		1	6	3	2					2	1	6	2	
1000 – 1199			11	10	3					2	8	9	5	1
800 – 999		1	10	23	9	1				1	10	15	4	1
600 – 799			19	19	5					2	10	23	6	1
400 – 599			11	18	7					2	22	26	11	
200 – 399			4	10						1	19	53	17	1
0 – 199			1							not analysed				
							Remaining plants (RP)							
over 1400		1	1					1		2	2	2		
1200 – 1399			2							2	6	1		
1000 – 1199	1	3	4	3					2	3	6	6		
800 – 999	3	7	16	7	1				2	1	8	3		
600 – 799		11	32	17	3		1		2	5	18	10	2	
400 – 599	1	14	37	26	2		1		3	11	27	14	2	
200 – 399	1	16	50	21	4			1	8	19	37	31	2	
0 – 199	3	9	25	15	4	1				not analysed				
	4	5	6	7	8	9	2	3	4	5	6	7	8	9

Depth of eyes; score: 1 (deep) – 9 (shallow)

Table 9. Correlations between tuber yield and extent of second growth in first year seedlings and in their tuber progeny

Tuber yield (g)	First year seedlings									Tuber progeny								
										Best plants (BP)								
over 1400					3	1		2				1	3		6	3	4	1
1200 – 1399					1	4	1	4	2					3	3	1	2	2
1000 – 1199					4	3	5	8	4	1		1		3	5	9	4	2
800 – 999					6	8	4	15	11					4	9	12	4	2
600 – 799					4	12	4	18	5					4	9	14	8	7
400 – 599				2	3	9	5	10	7				4	7	4	20	15	11
200 – 399					4	3		4	3					3	19	18	34	17
0 – 199						1				not analysed								
										Remaining plants (RP)								
over 1400						2					1	2		3				
1200 – 1399					2					1				3	2	1	2	
1000 – 1199		1		2	3	3	2							3	3	7	3	1
800 – 999	1			4	4	10	7	6	2				1	1	1	6	5	
600 – 799		1	2	5	16	15	15	7	2		2		1	2	9	15	6	3
400 – 599		1	4	7	7	23	17	17	4			1	1	13	11	17	12	3
200 – 399	1		2	6	19	19	17	24	4			2	4	8	22	33	23	6
0 – 199		2	1	1	5	11	11	16	10	not analysed								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9

Extent of second growth, score: 1 (extensive) – 9 (no)

Table 10. Correlations between tuber yield and homogeneity of tuber size in first year seedlings and in their tuber progeny

Tuber yield (g)	First year seedlings								Tuber progeny								
									Best plants (BP)								
over 1400				2	1	2	1						2	1	9	1	2
1200 – 1399				1	1	7	1	2					2	3	4	1	1
1000 – 1199				1	6	7	10					1	1	6	9	7	1
800 – 999	1		1	2	14	14	11	1			1	1	3	8	10	5	3
600 – 799				3	16	11	13					3	3	8	13	10	5
400 – 599			2	2	9	15	8					6	8	17	16	11	3
200 – 399				4	4	3	3				2	7	11	32	24	9	6
0 – 199							1		not analysed								
									Remaining plants (RP)								
over 1400			1		1				1	1		1	1	1	2		
1200 – 1399				1	1							1	3	1	1	3	
1000 – 1199		1	1	2	4	2	1						5	6	5	1	
800 – 999	2		3	7	15	5	2			1		2	2	1	5	2	1
600 – 799		2	7	18	24	11	1				1	2	6	8	11	8	2
400 – 599	2	2	8	19	23	17	8	1				9	17	14	11	6	1
200 – 399		3	7	18	36	20	8				5	5	13	40	16	15	4
0 – 199		1	2	7	21	14	9	3	not analysed								
	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9

Homogeneity of tuber size; score: 1 (no) – 9 (extreme) larity of tuber shape and with the depth of eyes. The values found in individual progenies were similar.

In the phenotypic variation of individual tubers selected from first year seedlings, similar values of the coefficients of correlation were found, the coefficients of correlation between regularity of tuber shape and depth of eyes assuming the values of r = + 0.52 for BBT and r = + 0.46 for BMT.

The correlation coefficients between tuber size and the above characters (regularity of tuber shape, depth of eyes and second growth) were found to be always smaller than r = 0.25 and are not presented in Table 11.

If values found in BMT were correlated with values found in their tuber progenies, the correlation was weak (r = – 0.08 to r = + 0.22). Much higher values were obtained when the repeatability of individual characters was evaluated (Table 6). It may be concluded that phenotypic correlations presented in Table 11 are not due to genetic correlations.

Discussion

The presented results demonstrate that if from field grown first year seedlings a definite number of individual better plants or the same number of better tubers were selected, the resulting clones were of similar value, the progeny of selected tubers being slightly better (Tables 2-5).

It does not mean that the evaluation of individual tubers is as effective as the evaluation of individual plants because the selection among tubers was much more extensive. The 180 best plants (BP) were selected out of a total of 720 first year seedlings, that is, 25% were selected. On the other hand, the 180 best medium size tubers (BMT) were selected out of a total of 5095 tubers. It follows that only 3.5% were selected (Table 1). The number of tubers was much greater than the number of seedlings. That means also that at least from some plants several tubers were chosen. As a consequence the advantageous plants, originating from selected tubers, (Table 2) could occasionally represent identical genotypes. It is not a disadvantage as individual selections are often lost due to chance variation (Davies and Johnson 1974) and if they are represented in the breeding material more than once, their chance of survival is increasing.

In big tubers and medium size tubers the regularity of tuber shape and depth of eyes were evaluated with similar reliability if the mean value of the tuber progeny was used as criterion (Tables 3-5). A higher value of the correlation coefficient obtained for regularity of tuber shape in big tubers (Table 6) may be simply due to a broader range of this character in big tubers (6-9) than in medium size tubers (7-9).

No practical difference was found in tuber yield, length of vegetative period and homogeneity of tuber size between the progeny of best plants (BP) and the progenies of best big tubers (BBT) and best medium size tubers (BMT) (Table 2). This indicates that selection of individual tubers is unlikely to produce a progeny with inferior tuber yield or inferior homogeneity of tuber size. Such a result could be expected as in general only a weak correlation is found between tuber yield of field grown first year seedlings and their tuber progeny (Domański and Świeżyński 1976; Pfeffer 1963; Zadina 1971) and big tubers or tubers with most regular shape are likely to originate from plants with rather regular growth, which

Table 11. Correlation coefficients between characters within first year seedlings, within tubers selected from first year seedlings and between selected tubers and their tuber progeny

Correlation	Group	Number of individuals	Correlated characters (1. and 2.)		
			1. regularity of tuber shape 2. depth of eyes	1. regularity of tuber shape 2. second growth	1. depth of eyes 2. second growth
Within first year seedlings	progeny A	236	+ 0.70[b]	+ 0.24[b]	+ 0.27[b]
	progeny B	233	+ 0.72[b]	+ 0.41[b]	+ 0.33[b]
	progeny C	232	+ 0.60[b]	+ 0.47[b]	+ 0.30[b]
Within selected tubers	BBT	60	+ 0.52[b]	+ 0.36[a]	+ 0.32[a]
	BMT	180	+ 0.46[b]	+ 0.42[b]	+ 0.24[b]
Between selected BMT and their progeny	1. in BMT 2. in the progeny	148	– 0.08	+ 0.03	– 0.00
	1. in the progeny 2. in BMT	148	+ 0.11	– 0.01	+ 0.22[b]

BBT = best big tubers
BMT = best medium size tubers
levels of significance: a – 0.05 and b – 0.01

may be expected to produce a higher yield. At the same time this is an indication of luck of negative correlation between high tuber yield and good tuber shape.

The selection of best big tubers was more effective than the selection of best plants in obtaining a progeny with larger tuber size (Table 2) and previous research demonstrated that big tubers are less variable in specific gravity (Świeżyński 1959). On the other hand from the best medium size tubers more advantageous plants were obtained and mean values of their progeny were usually higher (Table 2). It may be concluded that for the selection of individual tubers both the big and the medium size ones are useful.

The results presented in Table 11 indicate that chance variation is likely to favour the appearance of tubers outstanding at the same time in regularity of shape, shallow eyes and luck of second growth.

Individual characters were evaluated with different reliability. Regularity of tuber shape and depth of eyes were evaluated most successfully (comparatively high values of coefficients of correlation in Table 6, big differences between groups in Tables 2 and 7-8). On the other hand, the evaluation of second growth and homogeneity of tuber size was scarcely efficient (small differences between groups in Tables 2 and 9-10, no correlation for second growth in Table 6). It follows that in the preliminary evaluation of the seedlings much more attention should be paid to the first 2 characters, which may be also determined in individual tubers, and much less to second growth and homogeneity of tuber size, which are poorly repeatable.

From results presented in Tables 7-10 it may also be concluded that phenotypic variation in tuber yield is unlikely to interfere with the evaluation of tuber morphology. Both in first year seedlings and in their tuber progeny no correlation was found between tuber yield and the analysed morphological characters.

The selection of individual tubers may appear useful in practical potato breeding because:

1) it permits to leave harvesting plants individually, making much easier the mechanisation of the harvest,

2) it permits a successful selection of clones with regular tuber shape, shallow eyes and – basing on previously published data – high starch content.

Its main drawback, in comparision with the traditional harvest of individual plants, is the fact, that for propagation in the next year not the whole tuber yield of the plant but only 1 tuber is available.

The selection of individual tubers may be applied either in the selection of field grown first year seedlings or in the selection of first tuber progenies, originating from first year seedlings grown in pots.

The selected tubers may be reproduced next year in 2 main ways:

1) Growing single plants or pairs of plants, if seed are pre-sprouted and cut into halves. Wide spacing may be applied, which should facilitate mechanical individual harvest (Scholz et al. 1975).

2) Field plots with several plants originating from 1 initial tuber. The author successfully produced from best tubers plots of 40 plants and this way of propagating the breeding material was very efficient (Świeżyński 1971).

It appears that growing first year seedlings in field conditions combined with selection of individual tubers is likely to make possible the quickest breeding advance without excessive labour. Some breeders are growing first year seedlings in the field (Lam and Gerard 1976) and if whole progenies of first year seedlings are harvested mechanically for an individual tuber selection, much labor is saved at harvest and individual progenies may be successfully evaluated (Świeżyński 1971).

The tubers selected from field grown plants are likely to be a better planting material than tubers from first year seedlings grown in pots because they are larger and more homogeneous.

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