Selection for Tuber Characters Can Maintain High Specific Gravity in a Diploid Potato Breeding Population

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Abstract. A base population of high specific gravity clones was established from a diploid hybrid population of *Solanum tuberosum* Group Phureja and *Solanum tuberosum* Group Stenotomum previously adapted to the long-day growing conditions in North Carolina. This base population was subjected to two 2-year cycles of recurrent selection. During each cycle, selections in the field were made on the basis of tuber smoothness, shape, and size. Tubers from unselected clones were bulked by plots. Tuber specific gravity was determined for the selected and unselected (bulk) clones. Tuber specific gravity was significantly greater in the selected than in the unselected clones in each cycle of selection.

Most commercial potato cultivars grown in the United States are genetically related (Mendoza and Haynes, 1974). In attempting to broaden the genetic base for potato breeding, Haynes (1972) obtained ≈ 30 introductions each of *Solanum tuberosum* Group Stenotomum and *Solanum tuberosum* Group Phureja over several years, most of which were from the IR-1 collection at Sturgeon Bay, Wis. This interbreeding diploid population was subjected to seven 2-year cycles of recurrent selection for adaptation to the long-day growing conditions of North Carolina. This base population had not been subjected to selection pressure for tuber type. After the seventh cycle of recurrent selection, the population was screened for tuber dry matter, as measured by specific gravity. Seventy-two clones from this base population, which had tuber specific gravity >1.090 when grown at the Mountain Horticultural Crops Research Station (MHCRS) in Fletcher, N.C. in 1983, were chosen for our study. These 72 clones, which were not selected on the basis of any other tuber characteristics, comprised the high dry-matter base population used in this study. We then studied what effect selection in the field for tuber smoothness, shape, and size had on tuber dry-matter content, as measured by specific gravity, in this high dry-matter population.

On 1 June 1984, the 72 clones were planted in an isolated, inter-breeding seed nursery at MHCRS on a Hayesville loam soil in a randomized complete-block design with three replications of seven-hill plots. Since these diploids are self-incompatible, isolation and fertility were the only necessary provisions to ensure outcrossing within the nursery. In August, 20 fruits per plot were harvested and the seeds extracted. The three lots of seed from each maternal parent, one from each replication, were bulked. Tubers from the parental clones were harvested in September.

In 1985, the 72 parent clones were planted in four replications of 10-hill plots. The 72 clones were divided into two 36-clone sets for convenience. Each set was planted in a randomized complete-block design. From the 72 seed families, samples were sown and transplanted to peat pellets. For convenience in handling, the 72 families were divided into two 36-family sets. Seedling families were transplanted in four replications of 25-plant plots in a randomized complete-block design. Parent clones were planted on a Hayesville loam soil at MHCRS on 4 June, and seedlings were planted on a Delanco loam soil at MHCRS on 5 June. Spacing of par-

ents and seedlings within the row was 46 cm.

Tubers were harvested from the parental clones and seedling families the third week of September. Within the seedling families, individual-hill selection was made on the basis of size, smoothness, and shape. At least one hill was selected from each plot. From the unselected hills, five tubers per hill were placed in a bulk sample to represent the replication. Specific gravity was determined for the parental clones, the selected genotypes, and each bulk sample. All determinations were by the weight in air and weight in water method (Murphy and Goven, 1959).

In 1986, the best selected clone from each seedling family was planted in a seed nursery on 3 June on a Codorus loam soil in three replications of 7-hill plots in a randomized complete-block design to begin the second cycle of selection. In August, 20 fruits per plot were harvested and the seeds extracted. The three lots of seed from each maternal parent were bulked. Tubers from the parental clones were harvested in September.

In 1987, the 72 parent clones from the second cycle of selection were planted on 8 June on a Codorus loam soil, and their 72 seedling families were planted on 15 June on a Delanco loam at MHCRS using the same experimental design and spacing as in 1985.

The parental clone planting was lost to flooding on 1 July 1987, when 148 mm of rain fell. Tubers were harvested from the seedling families the third week of September using the same criterion as in 1985.

Mean specific gravity was computed for parental clones in 1985 and the unselected (bulk) offspring and the selected offspring for 1985 and 1987. Standard analyses of variance were performed on the mean difference of selected vs. unselected offspring on a per-plot basis for 1985 and 1987. The error terms from these analyses were used as an estimate of the variance of the difference in the selected and unselected populations for their respective growing season. From this, a *t* test ($P = 0.05$) was constructed to test the hypothesis that the means of the two populations were the same (Snedecor and Cochran, 1967).

The mean specific gravity of the parental clones grown in sets A and B in 1985 was 1.090 and 1.080, respectively. The mean specific gravity of the selected offspring in

Table 1. Number of observations (N) that went into the mean, mean specific gravity (SG), and the range of specific gravity of potatoes of selected (clones) and unselected (bulk) offspring grown in 1985 and 1987 in each set.^z

Set	Selected			Unselected		
	N	SG	Range	N	SG	Range
1985						
A	374	1.096	1.057-1.146	144	1.090	1.074-1.151
B	285	1.095	1.061-1.149	144	1.092	1.073-1.185
Total	659	1.096	1.057-1.149	288	1.091	1.073-1.185
1987						
A	150	1.093	1.049-1.125	144	1.088	1.074-1.103
B	156	1.090	1.043-1.129	144	1.085	1.064-1.097
Total	306	1.092	1.043-1.129	288	1.087	1.064-1.103

^zThe 72 families comprising the high specific gravity population used in this study were randomly divided into two 36-family sets (A and B) for convenience in handling.

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1985 for the two sets was 1.096, as compared to 1.091 for the unselected offspring (Table 1), a significant difference ($t = 5.74$, $df = 210$).

The mean specific gravity of the selected offspring in 1987 was 1.092, as compared to 1.087 for the unselected offspring (Table 1), again a significant difference ($t = 7.94$, $df = 207$).

In both cycles of selection for tuber characteristics, the mean specific gravity of the selected clones was significantly higher by 0.005 than that of the unselected clones. This difference indicates that selection for physical tuber characteristics in this population did not adversely affect specific gravity. In

fact, at least in this early stage of the breeding program, such selection led to higher specific gravity in the selected population than the unselected population. However, as indicated by the range of mean specific gravity values, there were undoubtedly several clones in the unselected population that had a specific gravity higher than some of the selected clones. Since the determination of specific gravity for individual clones can be prohibitively time-consuming as larger populations are tested, we are encouraged to note that selection can be made on visual observations in the field without negative impact on specific gravity.

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Promotion of in Vitro Leaf Growth of Inner Scales Excised from Dormant Onion Bulbs

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Abstract. Inner scales excised from dormant bulbs of the short-day 'Texas Grano 1015Y' onion (*Allium cepa* L.) were cultured in vitro and leaf growth was examined. Light promoted leaf growth, but no differences in leaf growth were observed for media pH between 4 and 7. Leaf growth rate in darkness was highest at 24C, reduced at 15C, and greatly reduced at SC. Kinetin promoted leaf growth at 1, 10, and 100 μ M. IAA was effective at 1 and 10 μ M, but not at 0.1 and 100 μ M. GA₃ promoted growth at 0.1 μ M. No inhibitory effects of ABA on leaf growth could be detected. Chemical names used: 1-H-indole-3-acetic acid (IAA), abscisic acid (ABA), gibberellic acid (GA₃), 6-furfurylaminopurine (Kinetin).

Dormant onion bulbs are almost impervious to external stimuli, and the length of dormancy is affected by cultivar and conditions under which bulbs are grown and stored (Thompson et al., 1972). Onions stored at 10 to 15C tend to sprout earlier than those stored at higher or lower temperatures (Thompson et al., 1972). Auxin, gibberellic acid (GA), and cytokinin levels have been found to be low and inhibitors high in dormant bulbs. The growth promoter vs. inhibitor condition reverses itself when leaf growth is initiated (Aung and Peterson, 1974; Isenberg et al., 1974; Thomas, 1969). Attempts to break dormancy artificially in whole bulbs by applying GA₃, GA₄, 1-naphthaleneacetic acid (NAA), and N⁶-benzyl-

adenine (BA) have been unsuccessful (Kate, 1965; Thomas, 1969). However, bulbs with the outer scales removed sprouted earlier (Kate, 1965), and excised inner scales will sprout when cultured in nutrient agar or sand (Jaffe and Isenberg, 1968; Mahotiere et al., 1976a, 1976b).

Our study was conducted to determine effects of medium pH, light, temperature, and plant growth regulators on leaf growth of inner scales excised from dormant onions and cultured in vitro.

Preparation of explants. Three layers of the innermost scales, with the basal plate attached, were carefully removed from medium-size (5.0 to 8.8 cm in diameter) bulbs of 'Texas Grano 1015Y', a short-day onion. The initial size of the explant was $\approx$ 3 cm high and 1 cm in diameter. For growth measurements, the length of the second outer leaf of the explant was considered to be zero when the scales were excised. Experiments were carried out using bulbs within 1 month of harvest (25 Apr. 1986). Bulbs were stored at 24C until used. The tissue was surface-sterilized with 70% ethanol for 1 rein, 10%

Table 1. Effect of medium pH and light vs. dark culture conditions on leaf growth of excised inner scales from dormant onions after 21 days in vitro culture.

Illumination	Leaf length (cm) ^a			
	Medium pH			
	4	5	6	7
Yes	5.6	6.4	8.1	5.9
No	8.6	6.1	9.0	8.8
Significance				
pH			NS	
Illumination			*	

^aMeans of nine cultures of inner scales. Initial leaf length was considered to be 0 cm.

NS, *Nonsignificant or Significant at $P = 0.05$, respectively, according to F test.

Table 2. Effect of plant growth regulator concentration on leaf growth on excised inner scales from dormant onions after 14 days in culture.

Concn (μ M)	Leaf length (cm) ^a			
	Growth regulators			
	Kinetin	IAA	GA ₃	ABA
0	1.8	1.8	1.8	1.8
0.1	3.5	4.3	4.9	4.0
1	7.6	7.9	3.4	4.5
10	9.5	7.6	3.6	3.0
100	12.1	5.7	3.9	1.6
Significance	**	*	*	*

^aMeans of nine cultures of inner scales. Initial leaf length was considered to be 0 cm.

*, ** Significant at $P = 0.05$ or 0.01, respectively, according to F test.

commercial bleach (5.2% sodium hypochlorite) solution for 2 rein, and then rinsed with sterile distilled water for 5 min. The basal end of the explants were placed 1 cm deep in medium. Nine explants were used for each treatment.

Preparation of media and culture conditions. To examine the effect of medium pH and light, the basal medium consisted of full-strength Murashige and Skoog (1962) inorganic salts, 30 g sucrose/liter, and 7 g agar/liter. The pH was adjusted to 4, 5, 6, or 7 with 0.1 N NaOH or HCl. Eight milliliters of medium were placed in 25 $\times$ 150-mm culture tubes and autoclave at 121C for 15

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