Supplementary text 1: Details on the crumpled mutation

Clot et al. High-density linkage map constructed from a skim sequenced diploid potato population reveals transmission distortion and QTLs for tuber and pollen production.

Phenotypic descriptions and incomplete expressivity

Crumpled (*crcr*) offspring can be recognized in seedling stage by deviations in the colour or shape of the cotyledons. While many seedlings in the two-cotyledon stage can have a normal seedling shape, most seedlings display a darker shade of green as compared to wildtype seedlings. There are also cases of merged and asymmetrical cotyledons (Figure 1). Occasionally, fused cotyledons form a cup or trumpet shaped tissue (not shown).

Figure 1: Merged and asymmetrical cotyledons

We grew 50 *crcr* offspring and followed them during the growing season. The severity of the phenotypic consequences of *crumpled* appeared to be highly variable. We noticed that ~35% did not develop much further than the two-cotyledon stage or were unable to direct apical meristematic activity into plant growth (Class A – Figure 2). In some cases, bunches of leaf primordia did not expand into normal foliage.

Figure 2: Examples of class A phenotypes.

However, ~55% developed into miniature plants with several internodes, reaching 5 to 10 cm height (Class B – Fig. 3). Plants had varying degrees of distorted foliage and/or asymmetrical leaf shapes (Fig. 4).

Figure 3: Examples of class B phenotypes.

Figure 4: Example of asymmetrical leaf shape.

Some 15 % developed into relatively healthy-looking plants with a normal root system. In some cases, the plants were hardly distinguishable from wild-type phenotypes, albeit of poor vigour (Fig. 5). Two of these later plants even developed aerial and underground tubers (Fig. 6).

Figure 5: Examples of Class C offspring with near wild-type phenotypes.

Figure 6: Crumpled individual with tubers.

Given these differences in the severity of the mutant phenotype we conclude that this is a mutation with incomplete expressivity. Misclassification of Class C plants is not expected, because at the earlies stages these plants were indistinguishable from other crumpled individuals and clearly different from wild-type plants. Only after some weeks they seemed to be able to recover more and more from the effects of the mutation. Nonetheless, a mass of undifferentiated tissue often remains visible at the base of the stem as indicated by the white arrow on figure 7.

Figure 7: Mass of undifferentiated tissue at the base of the stem of a recovered crumpled plant.

Earlier descriptions

The mutation was first mentioned by Simmonds (1965). He described *crcr* plants as very stunted, stems contorted, leaves crumpled, blotchy-streaky chlorotic. The material was

derived from a *S. phureja* accession C.P.C. 1776 (Paxman, unpubl.). Our material is also derived from a S. *phureja* accession PI 225696 (C.C.C. 561).

In another study (Jongedijk et al. 1990) the authors referred to a sublethal mutant and described them as stunted plantlets with contorted stems and crumpled leaves, generally dying 1-2 weeks after emergence.

Jacobs et al. (1995) had indications for linkage of this locus to chromosome *10* based on very few datapoints, which was recently refuted by Zhang et al. (2019) and by this study, where the cr/cr locus is mapped to chromosome *1*.
Zhang et al (2019) fine-mapped the locus to coordinates ST4.03ch01: 69,318,914 - 69,340,434 where the underlying gene showed homology to *SHORT-ROOT INTERACTING EMBRYONIC LETHAL* and was named *StSIEL* in potato. They re-named the mutation as *abnormal rooting 1* (*ar1*) and showed one illustration of the phenotype. To our opinion root development is not the most typical phenotype of this mutation. We propose to maintain the name *crumpled* (*Cr/cr*) to indicate this mutant phenotype.

References

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