Assignment of Endosperm Balance Numbers to the tuber-bearing Solanums and their close non-tuber-bearing relatives

R.E. Hanneman, Jr.
USDA, Agricultural Research Service, Vegetable Crops Research Unit, Department of Horticulture, University of Wisconsin, Madison, Wisconsin 53706, USA

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Abstract

The Endosperm Balance Number (EBN) of over 80 species and subspecies of the tuber-bearing Solanums and their close non-tuber-bearing relatives representing 13 taxonomic series has been determined, with no species assigned to more than one EBN level. Among North American species, most diploids are 1EBN, most tetraploids are 2EBN and all hexaploids are 4EBN; however, among South American species most diploids are 2EBN, most tetraploids are 4EBN and again all hexaploids are 4EBN. Thus species may be isolated from others of the same ploidy level by EBN differences, e.g., 4 × (2EBN) from 4 × (4EBN), while other species differing in ploidy but having the same EBN may be intercrossed, e.g., 4 × (2EBN) and 2 × (2EBN). Chromosome doubling or 2n gametes can be used to make a lower EBN species compatible with a higher EBN species. These findings also explain the major crossing difficulties previously inherent in the use of North American species in potato improvement. They also have direct implications for potato improvement, barring the occurrence of other incompatibility barriers. Any 4 × (4EBN) cultivar is endosperm compatible and thus will cross with 4 × (4EBN) and 6 × (4EBN) species. The 2 × (2EBN) haploids of 4 × (4EBN) cultivars likewise will hybridize with 2 × (2EBN) and 4 × (4EBN) species. All 2 × (1EBN) species are crossable with 2 × (2EBN) haploids through 2n gametes or chromosome doubling.

Introduction

The vast richness of germplasm available in the tuber-bearing and closely related non-tuber-bearing Solanums offers promise that the genetic treasure contained within will meet present and future needs as its wealth is realized and unlocked. This group of species has yielded many useful traits needed to solve particular problems, whether they be insect, viral, fungal, nematode or bacterial resistance, quality factors or other characteristics not available among cultivars. However, genes for these traits have not always been in species which readily hybridize with the cultivated potato. There are two gene pools, the North and the South American, which are isolated from each other based on crossability, with the South American gene pool having greater affinity for Tuberosum breeding stocks (Hawkes, 1958). While the South American species have been rather malleable in breeders' hands, the North American group has been difficult, with successful hybridizations only achieved by persistent pollination efforts. The crossability groups have been well-defined by Dionne (1961), Hawkes (1958), and Pandey (1962). These crossability groups have been presumed to be the result of stylar barriers.

With the advent of the Endosperm Balance Number (EBN) concept (Johnston et al., 1980), which requires a 2:1 maternal to paternal EBN ratio in the endosperm, independent of ploidy, a new understanding of interspecific crossability barriers has been realized. It is now known that diploid and tetraploid species can be isolated from others of the same ploidy level by EBN (Johnston & Hanneman, 1980, 1982) and that hexaploids can
Table 1. Assignment of Endosperm Balance Numbers (EBN) to wild and cultivated potato species arranged by series and continent

<table>
<thead>
<tr>
<th>Ploidy</th>
<th>Seeds per fruit (ploidy)</th>
<th>EBN</th>
<th>Designation</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bf North America</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Series bulbocastana</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>S. bulbocastanum</td>
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<tr>
<td>ssp. bulbocastanum</td>
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<td>36 (2x)</td>
<td>0</td>
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<td>ssp. dolichophyllum</td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>S. brachycarpum</td>
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<td>0</td>
<td>3 (4x)</td>
</tr>
<tr>
<td>S. demissum</td>
<td>6x</td>
<td>0</td>
<td>2 (4x, 5x)</td>
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<tr>
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<tr>
<td>S. hougasii</td>
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<td>0</td>
<td>4 (4x)</td>
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<tr>
<td>S. iopetalum</td>
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<td>0</td>
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</tr>
<tr>
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<td></td>
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<tr>
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<tr>
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<tr>
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<tr>
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<td>72 (3x)</td>
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<td>19 (3x)</td>
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<td>S. violaceimarmoratum</td>
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<td>&lt;1</td>
<td>6 (2x)</td>
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