The Monosomics of Nicotiana tabacum

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The first two monosomic types in *N. tabacum* were reported in 1926 by Clausen and Goodspeed. Since that time a collection of 24 such lines has been assembled largely through the efforts of the late Prof. R. E. Clausen. Some have appeared spontaneously, some as derivative types from hybridization of *N. tabacum* and *N. sylvestris* and some by the use of a genetically controlled asynaptic condition (Clausen and Cameron, 1944). The monosomics provide a convenient and time-saving method for localizing mutant genetic loci on specific chromosomes. It is only necessary to cross the various monosomic types (as ovule parent) with a homozygous recessive and examine the resulting progenies. As an example, it was found that when white flowered plants were thus tested the only population having white flowered plants was that derived from haplo-C. The plants showing the recessive character were all monosomic in constitution. While many such mutants have been assigned to specific chromosomes, a few have failed to give definitive results. In addition, all the members of certain translocation complexes have not been identified using the monosomic method (Cameron, 1952). Thus, it may be that one or two of the lines described here are not primary types.

Two monosomics in particular, haplo-D and haplo-U have been under suspicion but for quite different reasons. The former is characterized by the frequent occurrence of a trivalent at MI (metaphase I) in PMC (pollen mother cells). In cells where this association is resolved into its components the three resulting univalents are visibly different in size (one large, one medium, one small). The haplo-U type is associated with a mild asynaptic effect but it is usually possible to select plants, which are quite acceptable cytologically, for continuation of the stock. However, instead of the usual morphological distinction between 2n and 2n-1 plants, characteristic of the other monosomic populations, in each generation a confusing array of variants appears. The lines are maintained by pollinating selected monosomic plants with pollen from a highly inbred normal stock. The monosome is thereby introduced anew each season. Hence, any modification in the unpaired chromosome would have to occur in the uniform standard strain.

In order to utilize the monosomics in the identification of mutant loci with specific chromosomes it is advantageous to be able to recognize the 24 types on the basis of morphological characters which accompany the deficiency for each of the chromosomes. There has been no previous description of these in as much as the collection has been little used except in this laboratory. Now, however, monosomic lines are being established at several other stations and it seems appropriate to detail some of the more useful diagnostic features of each for the benefit of other investigators in this field. The original descriptions were outlined in considerable detail by Prof. Clausen and from them I have selected those which I have found most useful.

Figure 1. Flowers of **N. tabacum**—Red Russian tobacco—to show characteristic morphological effects of the monosomic condition. Upper row, left to right: normal disomic, haplo-C, haplo-F, haplo-G, haplo-K. Lower row: haplo-N, haplo-R, haplo-S, haplo-T.

The monosomic types have been designated by letters of the alphabet and classified as to genomic origin according to the nature of meiotic pairing in hybrids with *N. sylvestris* (Clausen and Cameron, 1944). In the following account, the more useful morphological features are outlined and, in each case, the character most likely to be of assistance in classification is emphasized. The flower measurements given in parentheses are averages of 10 representative flowers and show the tube length—limb spread, both measured in millimeters. These are to be compared with normal values of about (53-43).

The descriptions given below apply to the monosomic condition as expressed on a genetic background of Red Russian tobacco (var. Purpurea in earlier reports). This type differs in many characteristics from commercial varieties of the species. However, when one is familiar with the morphological features associated with deficiency for each of the 24 chromosomes it is relatively easy to recognize the corresponding types in intervarietal or interspecific hybrids involving *N. sylvestris*. The accompanying figure shows the nature of alteration of the disomic characters in selected monosomic lines.

Morphological features of monosomic types:

Haplo-A—Plant height—somewhat below normal. Leaves—smaller, basal constriction more pronounced. Flowers (48.6-43.1)—*somewhat paler in color, fading earlier*. Pollen—essentially normal. Monosome—medium small.

Haplo-B—Plant height—subnormal, sparsely branched. Leaves—smaller, narrow, basal constriction less abrupt, *auricles strongly reduced*. Flowers (53.6-41.0)—more strongly bent, color darker. Pollen—essentially normal. Monosome—very small.

Haplo-C—Plant height—often taller than normal, longer internodes. Leaves—narrow, basal constriction less abrupt. Flowers (58.6-43.7)—*longer and broader*, color paler in tube and throat. Pollen—marked abortion. Monosome—medium small.

Haplo-D—Plant height—normal but maturity delayed. Leaves—brighter green in young plants, *leaf base semi-broad*. Flowers (50.6-39.7)—slightly reduced in size. Pollen—essentially normal. Monosome—incorporated in a trivalent in about 50% of PMC.

Haplo-E—Plant height—subnormal. Leaves—smaller, constriction less abrupt. Flowers (51.3-41.1)—*calyx inflated*. Pollen—essentially normal. Monosome—very small.

Haplo-F—Plant height—subnormal, shorter internodes. Leaves—small, more erect. Flowers (44.5-37.5)—distinctly shorter, *limb fluted*. Pollen—moderate abortion. Monosome—large with characteristic medium constriction.

Haplo-G—Plant height—subnormal, meager inflorescence, maturity delayed. Leaves—small with rounded tips, basal constriction pronounced. Flowers (55.6-42.3)—*tapering gradually to the limb*, style short. Capsules—small and poorly filled. Pollen—variable as to cytoplasmic content but few grains completely aborted. Monosome—large.

Haplo-H—Plant height—normal but *stems and branches slender*, reduced branching. Leaves—small, narrow, basal constriction less pronounced. Flowers (51.8-38.3)—narrow tube, limb reduced, calyx lobes pointed. Pollen—high abortion but variable as to contents. Monosome—medium large.

Haplo-I—Plant height—normal, slender branches, delayed maturity. Leaves—small, more sharply pointed. Flowers (53.1-41.2)—corolla lobes pointed. Capsules—long, *narrow, poorly filled*, calyx inflated. Pollen—low abortion but dimorphic. Monosome—very small.

Haplo-J—Plant height subnormal, maturity delayed. Leaves small, narrow. Flowers (53.2-42.6)—*limb characteristically wavy* at maturity, color less intense. Capsules—small, poorly filled. Pollen—high abortion, sharp distinction between stainable and aborted grains. Monosome—medium.

Haplo-K—Plant height—subnormal, maturity delayed. Leaves—semi-broad at base. Flowers (48.3-36.7)—*tube short, infundibulum proportionately longer*, anthers small with delayed dehiscence. Pollen—low abortion, dimorphic. Monosome—very large, medianly constricted (cf. Clausen and Cameron, 1944).

Haplo-L—Plant height—above normal, stem heavy, maturity somewhat delayed. Flowers (48.6-37.1)—tube shorter and broader, *color distinctly paler*. Pollen—high abortion, variable in size. Monosome—large with prominent constriction.

Haplo-M—Plant height—subnormal, branching at the base. Leaves—large, basal constriction less pronounced. Flowers (53.9-40.7)—color fades to a purplish hue at maturity, *calyx conspicuously longer*. Pollen—higher abortion, variable in content. Monosome—medium large, characteristically ovoid.

Haplo-N—Plant height—distinctly subnormal, short internodes, compact inflorescence. Leaves—small, erect. Flowers (43.9-34.0)—*visibly smaller*, color darker red. Pollen—low abortion, dimorphic. Monosome—large with median constriction (cf. haplo-F).

Haplo-O—Plant height—close to normal. Leaves—slightly smaller, basal constriction more pronounced. Flowers (49.2-39.5)—size reduced, paler in color, stamens and pistils slightly exserted, *pollen shedding delayed*. Capsules—small, poorly filled. Pollen—low abortion. Monosome—medium large.

Haplo-P—Plant height—normal, maturity delayed. Leaves—small, tips rounded, *semi-broad at base*. Flowers (49.3-37.5)—limb narrow, corolla lobes less pronounced. Capsules—small, poorly filled. Pollen—marked abortion, subnormal grains variable in size. Monosome—medium large with characteristic subterminal constriction.

Haplo-Q—Plant height—reduced, little branching, maturity delayed. Leaves—narrow, basal constriction pronounced, *auricles strongly reduced, ruffled*. Flowers (54.8-38.8)—tube longer, limb spread reduced. Capsules—pointed, small and poorly filled. Pollen—very high abortion, sharply divided into two classes. Monosome—medium.

Haplo-R—Plant height—subnormal, thick stems, profusely branched. Leaves—small, darker green, auricles reduced. Flowers (49.2-41.9)—*enlarged infundibulum, wide throat*, color paler. Pollen—high abortion but completely empty grains rare. Monosome very large.

Haplo-S—Plant height—normal, maturity usually retarded. Leaves—lighter green, surface smooth. Flowers (47.3-41.7)—color more vivid, *stamens and pistil exserted*, pollen shedding delayed. Pollen—low abortion, grains variable in size. Monosome—large, frequently associated with a bivalent.

Haplo-T—Plant height—subnormal, maturity delayed. Leaves—small, darker green, basal constriction elongated. Flowers (56.0-41.7)—tube longer, *merging gradually into the infundibulum*, stamens and pistil relatively short. Capsules—small, poorly filled. Pollen—high abortion. Monosome—large, usually with a well defined constriction.

Haplo-U—Plant height—subnormal, bushy. Leaves—large, frequently *with a pronounced petiole*. Flowers (48.5-40.9)—corolla lobes acutely pointed, tube pale, limb and throat strongly colored. Pollen — high abortion, aborted grains variable in size. Monosome—medium large.

Haplo-V—Plant height—subnormal. Leaves—small, basal constriction less abrupt, auricles reduced. Flowers (47.0-39.8)—tube stout. Pollen—high abortion, *visibly so in freshly opened flowers.* Monosome—medium large.

Haplo-W—Plant height—subnormal, elongated internodes, sparsely branched, maturity delayed. Leaves *long, narrow,* sharply, pointed, auricles reduced. Flowers (52.8-40.8)—color lighter, pollen scanty, sometimes lacking in early flowers. Pollen—high abortion, aborted grains small. Monosome—large, but PMC frequently unobtainable during early flowering.

Haplo-Z—Plant height—normal, maturity conspicuously delayed. Leaves—small, basal constriction less pronounced, auricles less ruffled. Flowers (52.9-40.3)—style tends to be curved, limb frequently fails to open fully. Pollen—*abortion very high,* sharp distinction between normal and aborted grains. Monosome—large.

In spite of the apparent distinctions between the above types and normal *N. tabacum,* certain monosomics (notably B, E and O) always present difficulty in making an accurate classification. Fortunately, all three transmit the condition to a high percentage of their progeny. It is evident from the above descriptions that different monosomic types have certain features in common. For instance, the floral characteristics of haplo-G and haplo-T are very similar and the same is true of haplo-F and haplo-N. The latter resemblance may lead to difficulties in maintaining the haplo-N stock. Haplo-F plants appear spontaneously with a relatively high frequency in monosomic cultures and if one of these were selected for continuation in a haplo-N population the haplo-N type would be lost. Thus, it is advisable to use at least two plants as maternal parents in each generation.

Literature Cited

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