

Breeding Large-Seeded Alfalfa Seed Parents For Hybrid Recovery by Grading

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Hybrid alfalfa is desirable for a multiplicity of reasons. See Brummer, *Crop Science* 39:943-954, for a compelling argument for hybrids. Also see Riday and Brummer, *Crop Science* 42:716-723, 42:1081-1087, and 42:1088-1093 for more data and discussion. Increasing knowledge about the genomes of *Medicago sativa* and *M. falcata* is driving our interest in hybrids, currently.

Hybrids are a must for the future in our view as a method of managing and exploiting the genomic divergence between *M. sativa* and *M. falcata*. See Kidwell et al. *Crop Science* 34:230-236, regarding the divergence. The same divergence that has a potential for hybrid vigor also has a potential for unbalanced segregational variation. The background to our earlier thinking about genome divergence and unwanted variation is in the report "Segregation Distortion and the Nature of the Alfalfa Genome" on this website, Volume 1.

Our present thinking is greatly influenced by the concept of "Outbreeding Depression" (see a book by Lynch and Walsh, 1998, *Analysis of Quantitative Traits*, Sinaure Assoc. Inc.). Outbreeding depression occurs when outcrossing does not increase the fitness of progeny in advanced generations. There may be heterosis in the F1, but it is lost in advanced generations because the progeny are less fit than members of the original parental lines. Hybrids prevent outbreeding depression, synthetic generations enable it!

Our method of choice to produce an enriched hybrid product is large-seeded parents and grading. This permits large-seeded, self-sterile seed parents to be grown in mixed stands with an elite cultivar or other elite pollinizer to ensure adequate cross pollination. Harvested seed is then graded to recover an enriched hybrid grade, and the elite pollinizer can be marketed as variety not specified, or possibly a named variety.

Research on the concept of using large-seeded parents to recover a hybrid product by grading began in 1982. At that time, we tried to use hexaploid and octoploid plants that are naturally large-seeded. Seed production on the higher ploidy materials was never adequate, however. Meanwhile, we gradually increased the size of our tetraploid alfalfa to where selected clones have seed as large as octoploids. Hence, this report is based on using normal tetraploid alfalfa.

Mild inbreeding and S1 recurrent selection for seed size was conducted over several years as a hobby. The S1 progeny of the commercial cultivars that went into 'Columbia 2000' are the genetic base of our large-seeded material, with one genotype each from 'Blazer XL' and 'Legendairy' added along the way. We are

using selected large-seeded clones that are relatively self-sterile, for the time being, while working toward such lines that are seed-reproduced. We do not have the resources to select for pest resistance, but know that it can be enhanced by choice of pollinizer.

We are championing hybrids for better control of genetic and genomic factors, not for a quick breakthrough in yield. Hybrids alone do not ensure a yield increase. A top-cross hybrid coded WISCA-64 was in limited regional testing in the 1980s. It was produced by transplanting clone 6-4ms in a seed production field at Prosser, WA, and selectively harvesting the clone. Clone 6-4ms was found in a Saranac X Saranac cross 30 years ago, and is still maintained. The hybrid was consistently in the upper half of the trails, but not special. A synthetic with an enhanced hybrid content labeled WISYN-X was tested in several regional trails in the same period. It topped a trail now and then, but otherwise was just another experimental. In the production of WISYN-X, about half of the plants in the seed production field were male sterile. Seed production was near normal, and this is where we confirmed the advantage of having male steriles mixed in with pollinizers in the stand.

Potential increases in hybrid alfalfa biomass are not expected to be as great as those in grain crops where the ratio of grain to stover can be shifted. However, we should be able to benefit from hybrid uniformity, especially as we move from top-cross hybrids to double cross-type hybrids.

In conclusion, we are turning to hybrids in this century. Grading for an enriched hybrid seed content is a place to start. Importantly, it enables us to restructure our thinking, change our breeding strategies, and hopefully achieve yield increases this century.