Heterosis in alfalfa – breeding implications

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Abstract: The presence of large genetic variability in alfalfa leads to creation of various ranges of varieties adapted to specific environments and management systems. Semi-hybrid breeding strategies are based on crossing populations to avoid the need for inbred lines, in order to capture partially heterotic effects in alfalfa. Objectives of this research were to: test agronomic performance of newly created alfalfa semi hybrids; to reaffirm hybrid breeding strategies in alfalfa; to demonstrate breeding implications and used methods on the creation of alfalfa varieties. Dry matter yields of 3 alfalfa (*M. sativa* ssp. *sativa*) semi-hybrid populations (NS Jelena, NS Sila and NS Tara) were monitored from 2012 up 2017, in a series of trials in Serbia. NS Jelena is the first Serbian alfalfa variety released using semi-hybrid breeding approach (2014), while NS Sila and NS Tara were released in 2017. NS Jelena was created by crossing Serbian (Banat and Mediana) and Greek (Dolichi and Hyliki) heterotic pools, while NS Sila was created using Serbian (Banat), Iranian (Ghaher Yon Geh) and Spanish (RSI 20) heterotic groups. NS Tara was created by crossing previously confirmed heterotic groups from France (Pecy) and Spain (RSI 20). Genetic distance estimation was used as a method for evaluating progeny similarities within a population, for choosing adequate parents for crossing in case of NS Sila and NS Tara varieties. The obtained results clearly demonstrate advantages of the applied breeding approaches. In multi-site long-term trials (2013-2016), NS Sila (16.8 t ha^{-1}) and NS Jelena (22.8 t ha^{-1}) outyielded commercial checks NS Banat ZMS II (16.2 t ha^{-1}) and NS Mediana ZMS V (21.3 t ha^{-1}), currently most grown Serbian varieties. The breeding efforts, heterotic effects, and seed production of different types of semi-hybrids in variety NS Tara were studied in more details. Results coming from a two-year study (2016 and 2017) showed positive MP heterosis (5.5%-6.8%), but with no high parent heterotic effects, even yield performance was not statistically different compared to some commercial checks. However, in the same trial, another semi-hybrid population NS Jelena (27.8 ha^{-1}) had higher dry matter yields than NS Tara (25.5 ha^{-1}) and NS Banat ZMS II (26.5 ha^{-1}). In a different multi-site long-term trial with different cutting regimes (4 vs. 6 cuts), site-specific results showed that NS Tara outyielded (13.5 ha^{-1} - 17.6 ha^{-1}) commercial check (13.0 ha^{-1} - 16.6 ha^{-1}) in dry matter yields. The obtained results of dry matter yield performance of semi-hybrid alfalfa populations lead to several main conclusions. The selection of heterotic groups depends highly on: genetics uniformity of the heterotic pools, applied cutting schedule, designated environmental conditions for a population, and methods used for semi-hybrid seed production. Selected parental populations should belong to the same dormancy group and be similarly tolerant to abiotic and biotic stress, in order to reduce the genetic load. Bearing in mind that alfalfa is an autotetraploid species and that breeder's working on a population level or with population hybrids, in the following period have to be examined and experimentally confirmed if heterotic effects will still be present throughout the next 3 to 4 generations of semi-hybrid seed multiplication. The approaches and results given in this paper present the first attempt to explore and improve breeding of alfalfa in Serbia in the way that is more in line with other diploid field crops (maize, sunflower), but still with differences in the methodology applied and the results obtained.
Key words: alfalfa, breeding implications, dry matter yield, heterosis, semi hybrids