Increasing the energy in alfalfa using a selection approach targeting stems

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Increasing the proportion of forages in the diet of dairy cows above the current 60% while maintaining or increasing forage yield are essential for the long-term environmental and economic sustainability of dairy production in Canada. To achieve this reduction in the use of feed grains and to increase the dietary forage proportion ("milk from forage"), the energy of Canadian forages must be increased. Our preliminary work has shown that the neutral detergent soluble carbohydrate (NDSC = soluble sugars + starch + pectin) concentration in whole plants shows large diurnal variation due to strong interactions with the environment. The NDSC concentration in stems could constitute a more reliable selection criterion to improve the energy content in alfalfa. Our objectives were to develop high yielding and persistent alfalfa genetic material with increased concentration of stem NDSC and to evaluate the stability of this trait across environmental conditions and stages of development.

To develop genetic material, one cycle of recurrent phenotypic selection for stem NDSC was performed in a nursery composed of 2000 plants from four genetic backgrounds (cv. Megan, Genoa VR, Akori, and 54V48). An indoor trial comparing the initial population (NDSC 0) and the improved population (NDSC+1) was performed in 2017 at the Quebec Research and Development Centre (AAFC). Our results showed an improvement in NDSC concentration in stems (+9%) between the initial and the NDSC+1 population and this increase was also observed in the whole plant NDSC concentration (+8%).

To evaluate the stability of the stem-NDSC trait, two experiments using genotypes divergently selected for stem NDSC within one background (cv. Akori) were performed. These indoor experiments compared two groups of genotypes (ANDSC – and ANDSC +) across two harvest times (AM vs PM; Experiment 1), and two stages of development (buds vs flowering; Experiment 2) at two successive cuts (both experiments). These experiments showed that the ANDSC + group had higher stem NDSC concentration that the ANDSC – group in AM (+10%) and PM (+8%) cuttings, at the buds (+7%) and flowering (+7%) stages and at the first (+6%) and second (+11%) cut.

This work shows that stem NDSC concentration was improved through phenotypic selection and is stable across management strategies (harvest time, stage of development and cutting). Therefore, selection based on stem NDSC is effective and can be performed throughout the growing season. These results, while promising, need to be validated with outdoor field trials to determine if there is still a strong GxE interaction for this trait.