Evaluating the theory of general adaptation in red clover

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Many believe that natural selection in the regions where newly developed red clover varieties are intended to be grown, is the only effective and proven technique for maximizing herbage yield in the long-term. To date, selection techniques used to specifically identify genotypes with superior herbage yield were not successful in significantly improving the general adaptation of this species. The objective of this study was to evaluate whether natural selection in location where targeted for the newly developed red clover cultivars are anticipated to be grown, is an effective method for improving long-term persistence. Furthermore to better understand the impact of diverse environments on the development of broadly adapted cultivars with improved herbage yield and long-term persistence, this study was designed to evaluate and compare the effectiveness of natural selection for improving herbage yield and long-term persistence in diverse regions following the introduction of a new trait, root-lesion nematode resistance. Testing selected populations in diverse regions for similarity or dissimilarity in herbage yield will aid in developing an efficient strategy for improving red clover populations. In phase I of this study 1000 seedlings from a new breeding line (CRS15) with significant tolerance to root-lesion nematodes were evaluated for seedling vigour during the first two post establishment years at five locations across Canada: Charlottetown, PEI; Lévis, QC; Saskatoon, SK; Lethbridge, AB; and Agassiz BC. One hundred plants from each five location, characterized with superior seedling vigour, were intercrossed to produce five new synthetics. In phase II of this study the source population (CRS15) and the developed five new synthetics were seeded at 8 locations (the above listed and three locations in US: Madison, WI; Ithaca, NY and Brookings,SD). This trial evaluated persistence and herbage yield in the first and second post establishment years.

Year effect, site effect, genotype and genotype x location interactions were highly significant in both post seeding years. Compared to original breeding material (CRS15), selection resulted in small improvement in herbage yield across all locations. Significant decline in herbage yield was observed in the 2nd post establishment yield (5.7 t/ha) as compare to the 1st post

establishment year (9.9 t/ha). The decline in yield was observed at all location and the average yield in the 2nd post seeding year ranged from 3.8 (SD) to 8.6 (BC) t/ha. Discriminative analysis demonstrated that grouping variation among evaluation sites was larger in the 1st than the 2nd post production year. In the 1st post production year similar variations divided the evaluation sites into five groups: 1) PE; 2) SD; 3) BC, NY and QC; 4) SK and WI; and 5) AB. In the 2nd post production year similar variations divided the evaluation site into 3 groups: 1) PE; 2) SD; 3) BC, NY, QC, SK and WI.

These results indicate the number of evaluation sites can be minimized once sites have been characterized into groups based on similar variation during the assessment years. Furthermore, it appears that increasing herbage yield in red clover was not necessarily associated with conducting genotype selection in the region targeted for commercial production (Figure 1). Therefore, the results of this study contradict the presumed necessity for location specific evaluation and selection of red clover genotypes for improved performance at a given location and instead demonstrates that evaluation and selection of red clover genotypes conducted at multiple locations where the newly developed cultivars are anticipated to be grown results in the identification of superior lines with broader adaptation and consistent performance in variety of environment.

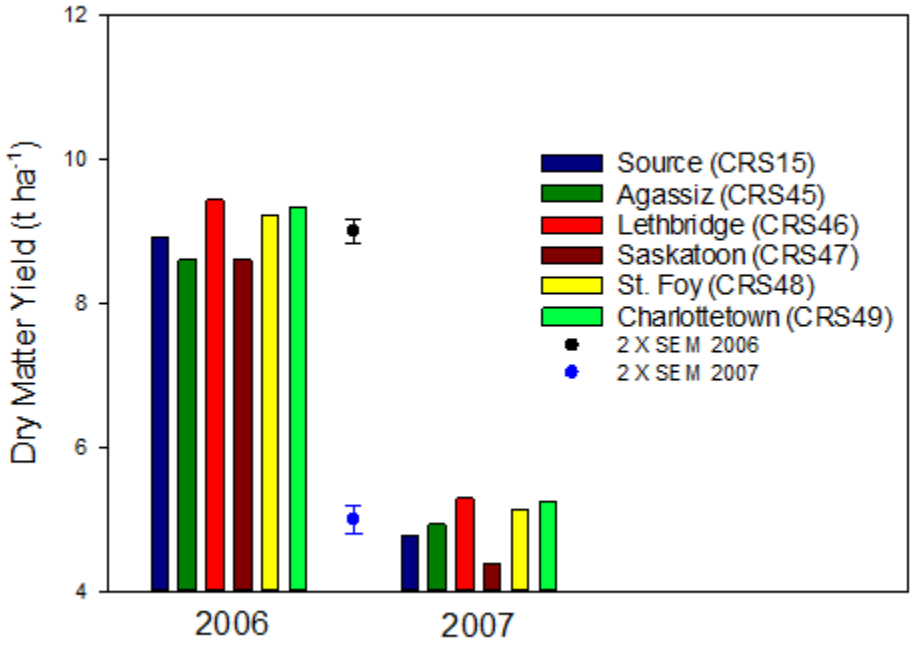

Figure 1. Selection gain for herbage dry matter yield following one cycle of selection in five diverse environments in the Northern Latitudes of North America.