Hairy Vetch: Developing a Winter-Annual Legume as a Cover Crop in the Northern U.S.

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Abstract:

Conventional production of summer annual species leaves soil barren for the majority of the calendar year. In fields without vegetative cover, un-sequestered nutrients are quickly lost and valuable top soil, rich in organic matter, can be lost by wind or rain. Poaceae and brassicaceae cover crop species (e.g. winter rye, pennycress) have shown sufficient adaptation to regions where winter survival and duration of growing season limit use. Winter-annual legumes, conversely, lack winter-hardiness for consistent winter survival and early biomass accumulation before spring planting of annual crops. *Vicia villosa* (hairy vetch), a diploid (2n=14), outcrossing annual species (Yeater *et al.* 2004), is perhaps the best candidate for providing a leguminous cover crop to northern U.S. growing regions. It is currently the most winter-hardy winter-annual legume (Brandsæter *et al.,* 1999) and can reliably provide 50 to 190 kg N ha^{-1} if grown to maturity (Teasdale *et al.,* 2004), which could fulfill the N requirement of maize (Decker *et al.,* 1994). Screening for winter-hardiness has routinely been accomplished through phenotypic recurrent selection, where plants that survive a test winter are intercrossed to form the next generation. While we have successfully identified ecotypes with variable levels of winter survival by testing entries over several environments and years, we have found that test winters can vary considerably for selection pressure and can result in inconsistent outcomes. It is therefore necessary to incorporate alternative approaches of screening for this highly quantitative trait. Two such methods that will be assessed to discriminate genotypes based on their level of winter-hardiness are controlled freezing (assessing plant survival following exposure to a series of freezing temperatures) and variable chlorophyll fluorescence measurement (quantifying leaf fluorescence as a means to indirectly measure stress tolerance). Within this experiment, factors such as growth stage and duration of cold acclimation will be evaluated for their effect on freezing tolerance, which is the foremost determinant of winter-hardiness (Pulli *et al*, 1996). The method that can best separate individuals that vary for this trait will be incorporated in a recurrent selection scheme. Genetic gain will be evaluated in replicated field trials to validate the effectiveness of the screening method. This research and breeding effort will serve to improve existing accessions of *V. villosa* and at a minimum would provide valuable insight in to developing winter-annual legumes for cover cropping systems.