



Technical Update:

PRS™-probes explain relationships between soil nutrient supply rate and non-native plant invasion

PRS™-probes are a [research tool](#) that can be used to elucidate the relationship between soil nutrient supply rates and non-native plant invasion. The ion exchange membrane surface of the PRS™-probe adsorbs soil ions in a manner similar to plant roots. The measured [nutrient supply rate](#) is an accurate depiction of the supply of [soil nutrients to a plant](#) over time. Therefore, researchers have used PRS™-probes to evaluate the competitive ability of non-native plants for soil nutrients as well as to determine the effect of a non-native plant on soil nutrient dynamics.

PRS™-probes provide an index of competition for soil N

University of Virginia graduate student, Jenica Allen, measured soil nitrogen (N) supply rate, using PRS™-probes, as an indicator of the ability of native and non-native populations of smooth cordgrass (*Spartina alterniflora*) to compete for soil N. The objective was to quantify the response among two native and three non-native populations of cordgrass to herbivory and N limitation and to determine whether N uptake could be used as a proxy for competitive ability for soil nutrients. According to the hypothesis, if selection had occurred for a more competitive, non-native cordgrass, the non-native population would have less growth and reproduction than the native population in the presence of an herbivore, but would be a superior competitor for N in N limited soil. The herbivore, a plant hopper (*Prokelisia marginata*), is found in the native range of cordgrass,

A closed mesocosm system was developed to measure the N limitation and herbivory effects on cordgrass growth, fecundity, and N supply rate. A pulse of ammonium nitrate was added to mesocosms in which a native or a non-native cordgrass plant were grown with or without an herbivore. PRS™-probes were buried directly into the mesocosm soil to provide a measure of soil N supply minus plant uptake of N or net soil N supply. By adding a pulse of N to a closed, N depleted system, it was assumed the N supply rate was an inverse function of plant uptake. Plant tissue has yet to be analyzed, but theoretically low N supply rate indicates high nutrient uptake which, in turn represents superior competition for soil N.

Jenica found that in one native and one non-native population of cordgrass, there was a marginally significant trend of a higher total N ($\text{NO}_3^- \text{-N} + \text{NH}_4^+ \text{-N}$) supply rate when the planthoppers were present on the cordgrass (Fig. 1). This, among other plant performance data, did not support the hypothesis that the non-native populations of cordgrass used in this study were superior competitors for N.

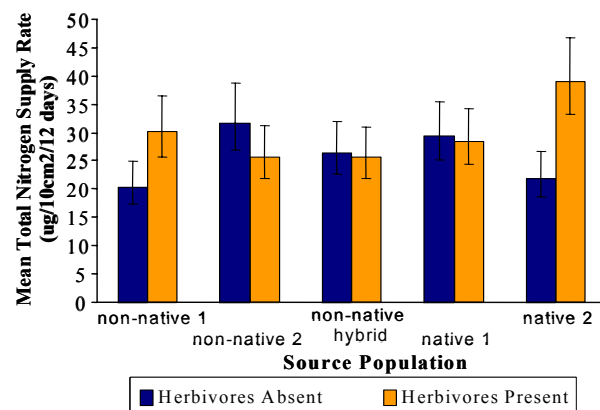


Figure 1. Effect of *S. alterniflora* population on mean of total N supply rate as influenced by presence of herbivore, *P. marginata*. Solid bars represent the absence of and dotted bars the presence of *P. marginata*. Trend of significant population X herbivore interaction (non-native 1 and native 1, $n = 20$; non-native 2 and native 2, $n = 18$, and non-native hybrid = 22, $P < 0.10$). Source: Jenica Allen, 2007, M.S. Thesis.

The concept of soil N supply rate as a predictor of N competition in a non-destructive, easy-to-use manner is promising, but it warrants further study. Jenica concluded that the N supply rate from the twelve day PRS™-probe burial was likely to represent plant N uptake, but it may have missed the uptake *capacity*, or the total possible N uptake by a plant, which was the necessary measure to predict competitive ability. A longer [PRS™-probe burial](#) is a potential solution to represent the uptake capacity of a plant.

Non-native, N-fixing plant species may not leave legacy of enhanced soil N supply rate

Soil N and P supply rate, measured with the PRS™-probes, helped to understand the effects of the non-native Scotch broom (*Cytisus scoparius*) on soil nutrient dynamics in a native Garry oak system on Vancouver Island, British Columbia. Broom's roots are colonized by



Technical Update:

nitrogen-fixing *Rhizobia* which may give it an establishment and growth advantage in N limited sites. One of the objectives of this study, conducted by University of British Columbia graduate student, [Jacqueline Shaben](#), was to compare the soil nutrient supply rate in Scotch broom invaded sites vs. un-invaded sites.

PRS™-probes were buried *in-situ* at Garry oak sites invaded and not invaded by Scotch broom for four consecutive, five-week burial periods without root exclusion cylinders. Each consecutive burial of PRS™-probes was placed into the slot in the soil vacated by the previous set. This provided a measure of N mineralization over 20 weeks and simulated the effects of a continuous sink, such as a plant root, on the soil N and P supply rate.

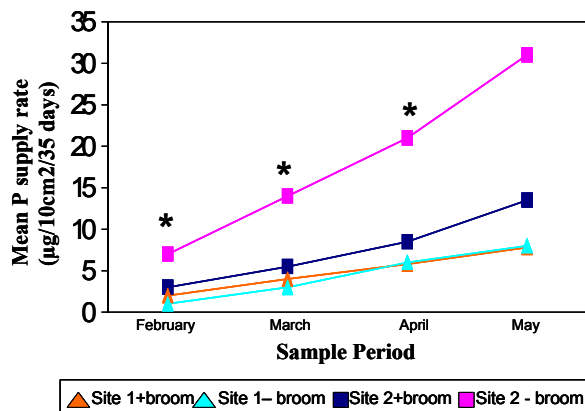


Figure 2. P supply rate in broom-invaded and un-invaded sites over the course of 35 days. The “*” indicates a significant difference in mean P supply rate between broom-invaded and un-invaded plots at site 2 on the specified date (Site 1, n = 3; Site 2, n = 5, P < 0.05). Source: Jacqueline Shaben, 2006, M.S. thesis.

Pre-season measurements of soil nutrient concentrations, by chemical-based extractants, showed that site 1 had low levels of N and P in both broom-invaded and un-invaded sites. On the other hand, site 2 had greater N content and moderate levels of P in the broom-invaded plots and high levels of P in the un-invaded site. For

site 2, this trend of P supply rates, measured using PRS™-probes, continued throughout the four months of soil nutrient measurements (Fig. 2). In fact, the P supply rate at site 2 in the broom-invaded location was over two times less than at the same site in the un-invaded location.

Jacqueline concluded that the low P supply rate in broom-invaded sites was due to enhanced broom uptake of P. She acknowledged that a similar phenomenon of P uptake was measured by Caldwell (2006). In broom-invaded areas, Caldwell (2006) measured higher levels of the enzyme phosphatase which catalyzes the release of phosphate from organic phosphorus compounds in the soil. Broom's association with high soil phosphatase levels may lead to its ability to take up greater rates of P.

Interestingly, soil N supply rate was not greater in the Scotch broom invaded sites nor was Scotch broom density or biomass correlated with soil N supply rate. For future work, a valuable comparison would involve burying the PRS™-probes in [root exclusion cylinders](#) in order to avoid competition between roots and PRS™-probes. By doing so, the PRS™-probes would measure the gross N supply rate rather than the net N supply rate. This method may uncover more of the N supply rate differences between broom invaded and un-invaded sites.

Literature Cited:

1. Allen, Jenica. 2007. Enemy Release and Evolved Increased Competitive Ability in *Spartina Alterniflora* Invading Pacific U.S. Estuaries. M.S. thesis. University of Virginia. Pg. 95-125.
2. Caldwell, B. A. 2006. Effects of invasive Scotch Broom on soil properties in a Pacific coastal prairie soil. *Applied Soil Ecology*.32:149-152.
3. Shaben, Jacqueline. 2006. Scotch broom (*Cytisus scoparius*) and soil nitrogen: Ecological Implications. M.S. Thesis. University of British Columbia. Pg. 7-45.

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or phone 1-877-978-1777 (TOLL-FREE) to speak with an R&D Co-ordinator, or visit us in person at the Ecological Society of America annual meeting in San Jose, CA, Aug. 5-10, 2007 at poster session 56, poster # 8080 on Aug. 9.
