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STUDY TITLE: Potential for Accelerated Bioremediation and Restoration of Oil-Impacted Marshes Through the Selection of Superior Oil-Tolerant Vegetation

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BACKGROUND: The cleanup of oil spills in coastal marshes remains a problematic issue because wetlands can be extremely sensitive to the disturbances associated with cleanup activities. As a result, there has been interest in developing alternative, less intrusive, oil spill cleanup/bioremediation techniques. The research reported herein assessed the feasibility of identifying superior oil-tolerant genotypes of Spartina patens and Spartina alterniflora (dominant brackish and salt marsh grasses, respectively) that may be utilized in the restoration and bioremediation of oil-impacted marshes, as well as in the rehabilitation of marshes in areas with a high amount of oil activity.

OBJECTIVES: To specifically addresses whether superior oil-tolerant populations of Spartina patens and Spartina alterniflora (dominant Gulf Coast brackish and salt marsh grasses) can be identified that display 1) superior growth response and plant production under oil stress, 2) superior vegetative regrowth through oiled soil, and 3) superior oil degradation potential.

DESCRIPTION: Transplants of Spartina patens and Spartina alterniflora were collected from Gulf Coast populations in Louisiana, Texas, and Florida. Each population was then propagated from a single stem (individual) to ensure that each population was represented by a single genotype. Ten different genotypes were propagated for each species. The oil tolerance experiments were run sequentially over a two-year period utilizing similar experimental protocols.

The ten different genotypes of each species were established in a uniform potting mix of approximately 10% organic matter content by weight. The soil of the treatment pots was oiled with South Louisiana crude oil at rates known to be stressful from previous research (5 L oil m^{-2} for S. patens and 8 L oil m^{-2} for S. alterniflora). The oil was applied directly to the surface flood water of the treatment pots and allowed to slowly drain through the soil column over a period of about two hours. Drainage was stopped just prior to the drainage of any oil, thereby ensuring even oiling of the substrate without loss of oil. For each pot, the drain water was collected in a reservoir bucket and subsequently slowly returned to the top of the treatment pot soil. The control pots received no oil, but were similarly drained and had the solution returned to the surface of the pots. Throughout the study, water levels were maintained at the level of the soil surface. Measurements of plant growth and physiological responses were conducted during the growing season, after which an initial harvest of aboveground biomass was conducted. Vegetative regrowth through the oiled soil was monitored for an additional three months, after which a final harvest was conducted and residual oil in the soil determined**.**

SIGNIFICANT CONCLUSIONS: In both Spartina patens (brackish marsh dominant) and Spartina alterniflora (salt marsh dominant), significant intraspecific variation to oiling was observed in a number of plant responses. Of the ten genotypes assessed in each species, several genotypes in each species could be identified that displayed superior oil tolerance in terms of single and multiple plant-growth responses to oiling. This finding has important ecological and applied value. Oil-tolerant genotypes of these species may be planted in marsh rehabilitation (restoration and creation) projects in areas of high oil activity, thereby potentially increasing the resiliency of these marshes to oiling, should an oil spill occur. Of the three oil-tolerant genotypes of Spartina patens identified, two of these genotypes also displayed the potential for accelerating the degradation of oil, thereby indicating the potential for enhanced rates of bioremediation (phytoremediation).

STUDY RESULTS: Highly significant genotype differences in a number of plant responses were detected in both species when oiled. Differences between genotypes generally became more pronounced with time, with the exception of leaf expansion rate, which proved to be a less sensitive short-term indicator of oil stress than photosynthesis (net CO_2 assimilation rate). Three genotypes of Spartina patens and three genotypes of Spartina alterniflora were identified that maintained high rates of photosynthesis when oiled and also generally performed better than the other genotypes in terms of a number of plant growth response variables, including regrowth through the oiled soil. Univariate statistical analyses were unable to detect any significant differences between genotypes

in oil degradation rates in either species, although multivariate techniques did detect genotype differences in Spartina patens.

A multivariate analysis (factor analysis) that was conducted on a suite of plant growth response variables and residual oil confirmed that three superior, oil-tolerant genotypes could be identified in each species (both Spartina patens and Spartina alterniflora) that performed significantly better than the other genotypes. When oiled, these oil-tolerant genotypes characteristically displayed less tissue death, maintained higher plant productivity, and demonstrated a greater ability to successfully produce new shoots through the oiled soil. Analysis of oil-degradation factor scores in S. patens further revealed that two of the three oil-tolerant genotypes demonstrated significantly greater oil-degradation potential than other genotypes. For both species, it is likely that in the long term (and under field conditions), greater rates of oil degradation would be associated with those genotypes that display less stress and greater plant productivity.

STUDY PRODUCT(S): M. W. Hester, Q. Lin, I. A. Mendelssohn, and D. J. Desroches. 1998. Potential for accelerated bioremediation and restoration of oil-impacted marshes through the selection of superior oil-tolerant vegetation. A final report by Southeastern Louisiana University and Louisiana State University for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA. Contract No. 14-35-0001-30660-19927 OCS Study MMS 2000-042 62 pp

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