Nitrogen research shows how some plants invade, take over others

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Biologists know that when plants battle for space, often the actual battle is for getting the nitrogen.

Now, research at the University of Nebraska-Lincoln gives important new information on how plants can change "nitrogen cycling" to gain nitrogen and how this allows plant species to invade and take over native plants.

In an article published July 6 in the scientific journal Proceedings of the National Academy of Sciences, UNL biologist Johannes "Jean" Knops demonstrates why one invasive plant species is replacing native species -- it's because of its ability to take up and hold on to nitrogen.

Biologists know that nitrogen is crucial to plant growth that invasive species often grow better and acquire more nitrogen, but have been uncertain about which mechanism allows invasive species to gain an advantage.

Over seven years' study at the Cedar Creek Ecosystem Science Reserve in central Minnesota, Knops and PhD candidate Ramesh Laungani studied the nitrogen pool and fluxes in the ecosystem that included seven grassland and forest species, including the Eastern white pine (*Pinus strobus*), a species that is rapidly invading Minnesota prairies. Over time they discovered that the pine had accrued nearly twice as much biomass as the next most productive species, and more than three times as much biomass relative to the other species.

"The higher productivity of the white pine is caused by an increased biomass nitrogen pool that was not driven by increased ecosystem level nitrogen inputs," Knops said. "But we found the white pine takes up nitrogen and holds on to it much longer, with leads to an accumulation of much more nitrogen in the plant and a depletion of nitrogen in the soil. We concluded high nitrogen residence time was the key mechanism driving the significantly higher plant nitrogen pool and the high productivity of that species."

In other words, pines mine the soil for organic nitrogen, decrease soil fertility and use this nitrogen to outcompete other species.

Knops, a plant and ecosystems ecologist, said the higher nitrogen residence time creates a positive feedback that redistributes nitrogen from the soil into the plant's nitrogen cycling. And this strengthened the species to support its invasion.

"What this higher nitrogen residence time means is that the plant is taking nitrogen from the soil and using it to make the plant grow more efficiently, and it also gives them an upper hand in being able to invade other species."

Biologists had identified six mechanisms that influence plant nitrogen use or acquisition: photosynthetic tissue allocation, photosynthetic nitrogen use efficiency, nitrogen fixation, nitrogen-leaching losses, gross nitrogen mineralization and plant nitrogen residence times. This study is the first to study all together and pinpoint the mechanism that explains why this pine is a successful invader.

Knops said he was somewhat surprised by the pines' ability to pull so much nitrogen out of the soil, especially in the degraded old fields that were studied.

Knowing this finding about nitrogen cycling with the white pine species may lead to important discoveries in how to stop invasions of other non-native species, like the Eastern red cedar, a destructive invader in the Great Plains; green ash, hackberry, or Chinese elms, or eventually to weedy exotic grasses that invade our native rangelands.

The study is the latest of several Knops has conducted at the Minnesota field site; this one began in 1999 with data taken in 2006. He has other projects in the mid-stage of 10- to 20-year timeframes, one looking at the establishment phase of pines, and another on grassland systems and their invasive species and abundance. He said his research field does require patience and longterm funding.

Source: University of Nebraska-Lincoln (news : web)