**Executive Summary**

**Development of a ureide tissue test for soybeans**

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Soybeans obtain nitrogen (N) from the soil in one of two forms: nitrate from the soil solution, and ureides from the nodules. The bacteria in the nodules that fix nitrogen, *Bradyrhizobium japonicum*, take N2 gas, and convert it into ammonium (NH4+). Soybeans are not good at transporting ammonium, so the root cells convert it to two compounds called ureides. We developed a new method of analyzing plant tissues for ureides. Our objective was to calibrate the ureide tissue test, by comparing the response of soybeans to inoculation, to the concentration of ureides in the plant axes (stems plus petioles).

Inoculation studies were performed in 2007, 2015, and 2016, at five sites total. Three of the sites were "virgin" sites, and two had a very limited history of soybean production (typically soybeans grown once, several years before). Different types of inoculation treatments were employed at the different sites, and included: inoculation of wheat the year before to "pre-establish" the bacteria in the soil, seed inoculation with a liquid inoculant, seed inoculation with a peat inoculant, a granular inoculant applied in-furrow at planting, and a combined seed and in-furrow inoculation.

The results of these five trials with regards to seed yield are shown in Figure 1. There is scatter in the results, which is expected when combining data over five locations, but two things are clear. Greater than 1500 ppm of ureide-N in the plant axes at flowering was associated with abundant N fixation. Less than 1000 ppm of ureide-N in the plant axes are associated with inadequate N fixation. The results of the five trials with regards to seed protein yield are shown in Figure 2. Again, greater than 1500 ppm of ureide-N in the plant axes at flowering was associated with abundant N-fixation. Less than 1000 ppm, one should be very concerned that N-fixation is inadequate.

Another thing we observed in conducting these trials, is that on fields with no history of soybeans, seed inoculation alone was extremely beneficial, but inadequate to maximize grain or protein yield. On "virgin" land, it seems that dual inoculation (seed plus granular in-furrow) or pre-establishment (inoculation of wheat the year before, plus inoculation of the seed), gave the most ureides in the plant, and best seed and protein yields.

We also related the response of soybeans to inoculation to the number of the symbiotic *B.* *japonicum* in the soil at planting. We never observed a response to inoculation when there were greater than 100 per gram of these bacteria in the soil. In a rotation study at Carrington, where soybeans have been grown many times, the numbers of these bacteria in the soil was greater than 2000 per gram, even four years away from soybeans.

Figure 1. Relationship between the ureide-N concentration of soybean axes (stems plus petioles) and yield loss, when comparing all treatments to the best inoculation treatment at that site. Values greater than 3000 ppm were graphed as 3000 ppm.

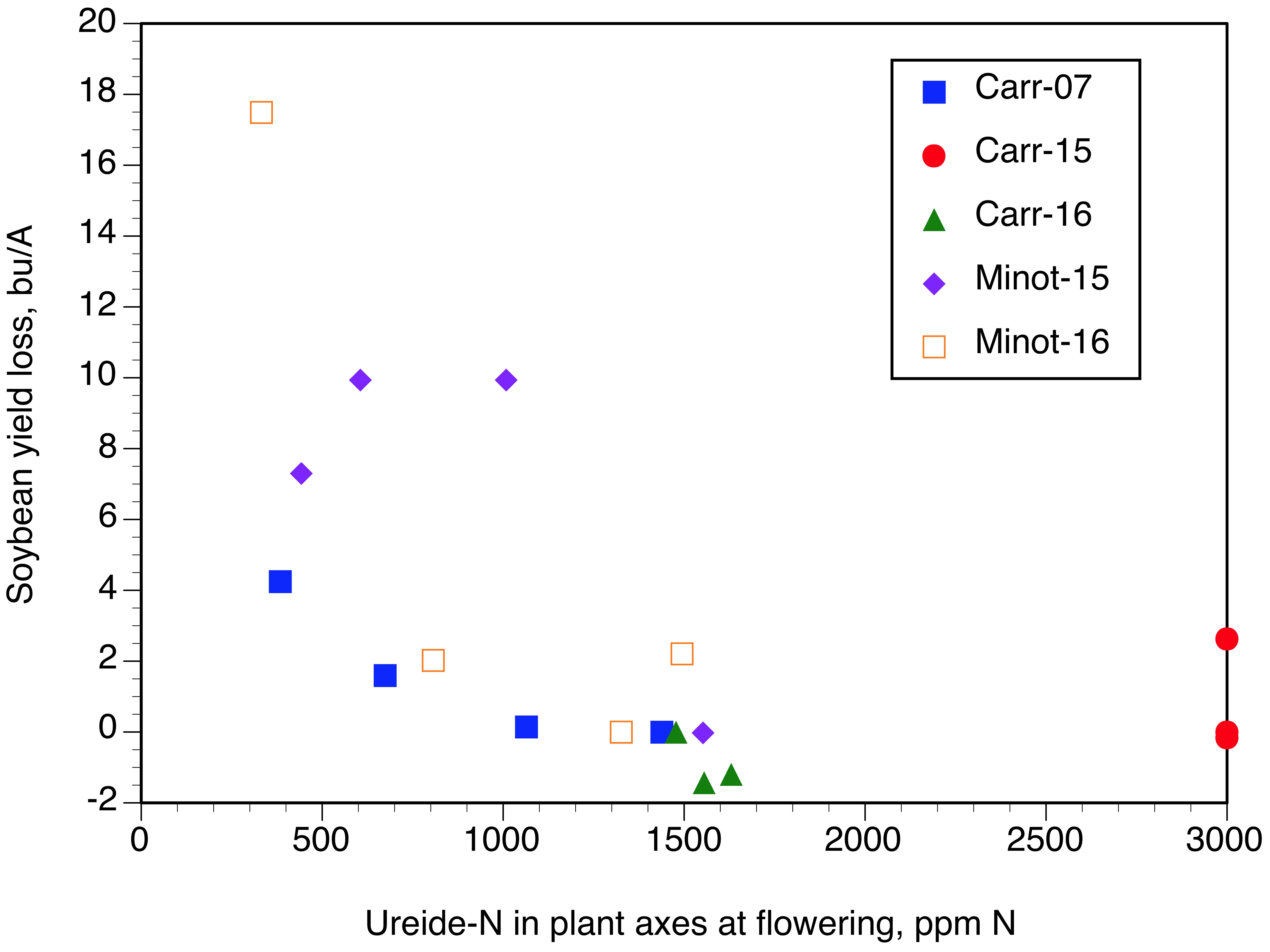


Figure 2. Relationship between the ureide-N concentration of soybean axes (stems plus petioles) and protein yield loss, when comparing all treatments to the best inoculation treatment at that site. Values greater than 3000 ppm were graphed as 3000 ppm.

