AGRONOMY

Soybean Crop Rotation in Manitoba

Crop rotation affects soybean N and P acquisition by symbiotic microbes and soybeans do not provide nitrogen credit to subsequent wheat crops.

LIKE OTHER LEGUMES, soybean's capacity to acquire phosphorus (P) and nitrogen (N) is related to symbiotic relationships with soil fungi and bacteria, respectively. Arbuscular mycorrhizal fungi (AMF) behave as an extension of the root itself, and can access P otherwise unavailable by penetrating soil pores too small for roots. *Bradyrhizobium japonicum* bacteria, housed in soybean root nodules, fix atmospheric N, reducing requirements of soil or fertilizer N. The effectiveness of these two microbes on soybean crop nutrition are affected by environmental and management factors.

To explore the effect of preceding crop on soybean yield, mycorrhizal colonization, and N fixation, two-year cropping sequence field trials were set up at Carman, Portage la Prairie and St. Adolphe in 2012–2014. Canola, corn, soybean and wheat were grown prior to soybean. Even within the short timeframe, there were differences in N fixation between sequences: soybeans grown on corn stubble generally had a higher proportion of N fixation (70.5–77.6%) and soybeans grown on canola had lower fixation (39.0–67.6%) than the other sequences. The low residual soil N levels after corn compared to canola explains these results: under levels of high soil N, soybean are less dependent on rhizobium as an N source and corn, having a high carbon to N ratio, immobilized more soil N, leaving little for the proceeding soybeans (see graph).

AMF colonization on soybean was also greater when grown on corn (53.5%) or soybean (54%) residue compared to wheat (45.1%) or canola (41.8%) residue. Because AMF do not colonize canola roots, soil AMF populations decline in a year where canola is grown. Colonization was also reduced by high residual soil P levels, but unlike soil N, was not correlated to preceding crop.

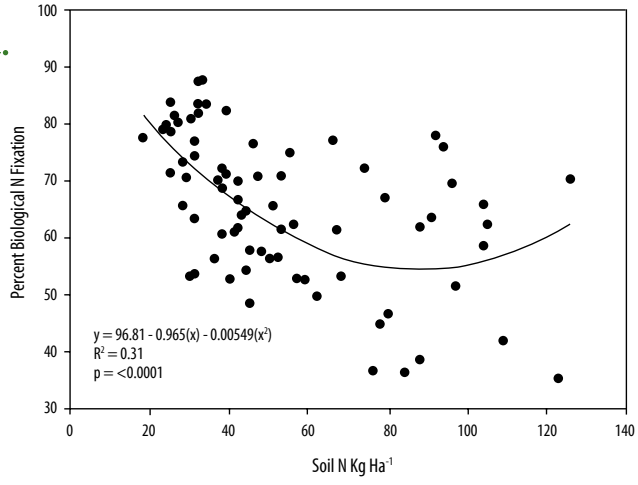
Preceding crop also affected soybean yield, though trends were not consistent. Although crop sequence had no effect at two of five site-years, corn-soybean and wheat-soybean sequences proved to be more consistent across site-years than canola-soybean and soybean-soybean sequences. Short-term rotation choices may have little effect on yield, but we can use the knowledge of soil microbes' role in P and N acquisition when growing soybeans on low fertility soils to maximize crop nutrition.

Legume residue decomposition can also contribute soil N so fertilizer recommendations are often adjusted to include an "N credit" for subsequent crops. Soybean, however, removes relatively high levels of N in the harvested grain and N credits vary widely with soil/climatic conditions and subsequent crop. Crop rotation studies on the Canadian Prairies have traditionally excluded soybean, but due to the rapid expansion in acreage in Manitoba, N credits for soybean needed to be quantified with a second field experiment.

Wheat, fertilized with 0, 28, 54, 80 or 107 lbs N/ac was planted on either soybean or canola stubble. The N credit of soybean is determined by comparing the amount of N fertilizer required for the wheat crop that follows the canola reference crop to produce the same yield as the wheat crop grown after soybean. In three of the four site-years, yields of wheat following soybeans was the same or lower compared to wheat following canola. Where wheat responded to N fertilizer, the yield of wheat following canola was always higher than following soybeans.

The lack of response to N fertilizer in these trials could have been due to the "masking effect" of the high organic matter levels (resulting in soil N mineralization) or the loamy textured soil (resulting in leaching of N fertilizer). Interestingly, soybean residues returned less N to the soil (22–41 lbs N/ac) than canola (29–80 kg N/ha). In addition, canola had a lower C:N ratio compared to soybean, and combined with a shorter growing season (i.e. longer period of residue decomposition) it was not surprising then that canola residue immobilized less soil N. Overall, soybean did not provide an N credit to the wheat crop, but rather, showed negative N balance.

Effect of residual soil N on biological N fixation in soybean averaged across five site-years.



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