LIVING LAB - ATLANTIC

Abstract

This study was conducted to evaluate yield responses of four potato (Solanum tuberosum L.) cultivars ('Russet Burbank', 'Shepody', 'Gold Rush', and 'Russet Prospect') and soil N dynamic changes to two 3-year rotations in Prince Edward Island, Canada. The two rotations were the local industry standard potato–barley (Hordeum vulgare L.)–red clover (Trifolium pratense L.) rotation (PBC) and an alternative potato–soybean (Glycine max L.)–barley rotation (PSB). All potato cultivars received 170 kg N ha^{-1} input at planting without irrigation. Soil mineral N content before potato planting was significantly higher under the PBC rotation. However, the PBC rotation produced significantly lower yields, suggesting the possibility of excessive N supply from the plowed-down red clover. While cultivar and the interaction between cultivar and rotation did not show a significant difference in yield, yields of all cultivars were positively affected by the PSB rotation. The Gold Rush cultivar was affected the most (36%), followed by Russet Burbank (17%) and Prospect (14%) cultivars, with Shepody being the least affected (3%) by the alternative PSB rotation. Russet Burbank was the highest yielding cultivar under both rotations. With the three russet cultivars combined as a single russet cultivar, the PSB rotation significantly increased tuber yields, while the Shepody cultivar did not significantly benefit from the PSB rotation, suggesting that the russet cultivars responded more sensitively to the alternative rotation.

Field Expriment

Photo 1. Experiment plots

The experiment was conducted at the Harrington Research Farm of Agriculture and Agri-Food Canada, 12 km northwest of Charlottetown, PEI, Canada from 2014 to 2017. The experimental field had a slope of about 1.5%. The soil was classified as Orthic humo-Ferric Podzols and Gleyed Eluviated Drystic Brunisols in the Canadian soil classification system. Russet Burbank, Shepody, Gold Rush, and Prospect cultivars were chosen for this study. Russet Burbank is a late-maturing cultivar with large tubers. Shepody is an early to mid-maturing cultivar with medium tubers. The Prospect is a mid-season cross-bred (Russet/Shepody) cultivar that produces large tubers and matures earlier than Russet Burbank. Gold Rush is a mid-season russet cultivar with average-sized tubers. The experimental factors included two rotations and four cultivars. The two rotations were randomly assigned on 12 plots (six replications). Each plot was subdivided into two sub-plots in the final year (2017) to accommodate the four cultivars. In the reference year of 2014, all plots were planted with the Russet Burbank cultivar and managed identically in order to create uniform fertility conditions before 2015. The PBC and PSB rotations were initiated in 2015 with barley and soybean, respectively. Red clover was the second crop in PBC and barley for PSB in 2016. The rotations were completed with potato cultivation in 2017. In this study, the N application rate of 170 kg N ha^{-1} was banded to all treatments as Nitrogen–Phosphorus–Potassium (17–17–17) compound fertilizer at planting time.

Soil Mineral N and Potato Yield

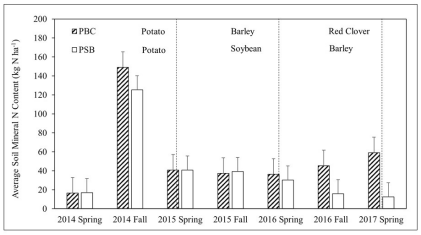

Figure 1. Soil mineral N

The PBC plots had a significantly higher soil mineral N content ($p < 0.001$) in the spring of 2017 before planting. As demonstrated in Fig. 1, the preceding red clover crop in the PBC plots led to significantly higher soil mineral N content after the completion of one rotation cycle from 2015 to 2017. On average, the PBC plots contained 59 kg N ha^{-1}, representing 4.7 times more soil Nm than the PSB plots with 12.5 kg N ha^{-1}. The standard deviation of soil mineral N content in the PBC plots was 25.2 kg N ha^{-1}, compared to 6.5 kg N ha^{-1} in the PSB plots. This indicates that the PBC plots demonstrated a considerably large spatial variation in soil mineral N content while the soil Nm in the PSB plots was relatively uniform. soil mineral N content was not significantly different between cultivars within the same rotation system for both PBC and PSB treatments.

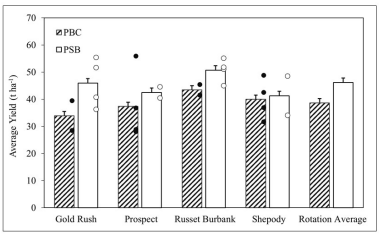

Figure 2. Tuber yields

We found that the PSB rotation resulted in higher potato yields for all cultivars (Fig. 2). On average, potato yields were 46.2 t ha^{-1} in the PSB plots, compared to 38.6 t ha^{-1} in the PBC plots representing a 19.5% difference. Under the PSB rotation, Russet Burbank, Gold Rush, Prospect, and Shepody yielded 50.7, 45.9, 42.5 and, 41.3 t ha^{-1}, respectively. In contrast, 43.4 t ha^{-1} of tuber yield was produced by Russet Burbank, 33.9 t ha– 1 by Gold Rush, 37.3 t ha^{-1} by Prospect and, 39.9 t ha^{-1} by Shepody under the PBC rotation. The differences in yield between cultivars under the two rotations were not statistically significant ($p > 0.05$), likely due to the relatively small sample size. However, increasing the sample size by combining the three russet cultivars (Russet Burbank, Gold Rush, and Prospect) into a single Russet group revealed that the PSB rotation significantly increased the yield ($p < 0.05$) (by 24% on average).

N Supply from Red Clover

The elevated mineral N content in PBC plots was probably sourced from the decomposition of the plowed-down red clover biomass. The lower yield of the PBC rotation despite higher mineral N available at planting was likely caused by an oversupply of nitrogen from red clover residue decomposition. Results indicate that potato growers should adjust the N application rate based on pre-plant soil N concentration by taking into account extra N supply from residues of nitrogen-fixing cover crop such as red clover.

Yield responses of four common potato cultivars to an industry standard and alternative rotation in Atlantic Canada

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