Barley Yield and Grain Quality Effects of the Spatial Soil Variability of a Field in Carrington

Szilvia Yuja and Mike Ostlie

Barley that is sold for malting must meet strict quality requirements. Using the right management practices like applying the correct rate of fertilizer, good timing of pesticide application, and timing of harvest, can be controlled. Some things like the weather, and the properties of the soil inherent in your field create variability that can supersede management practices. Virtually all fields have some variability in soil properties. Some of it is due to topography and some is due to other soil forming processes. Yield monitors are excellent tools to show these variabilities and where the problem areas might be. Homogeneity of grain quality is important to brewers because grains of differing quality will behave differently during the malting process. With continuous innovations in precision ag, it is now becoming realistic to adjust our management every few feet within a field. For this reason, it may be helpful to identify the soil properties most influential to barley yield and quality.

We have been conducting a barley trial for three years where the trial area falls on an elevation gradient. We did this to be able to apply treatments at different soil health and fertility conditions within the same field. The difference in elevation from the lowest to the highest point is only about 4 feet, yet it was observed that yield is greatly reduced on these little hill tops. Much of the trial area did not receive any treatment, therefore crop outcome would have been the direct result of location. This article discusses observations related to untreated areas only. The trial was established on the same plots in 2016 and 2018, and we have comprehensive soil data from that area. Grain protein and plumpness from untreated plots was only available in 2018.

Based on past observations of crop growth, we assumed that soil fertility would have some correlation to the micro elevation of each point in the field. This was true for some values, like organic matter or pH which followed the contours of the land very closely. For example organic matter correlated well with both elevation and yield (Figure 1). However we noticed that there comes a point on the slope where differences in crop growth become very noticeable compared to the rest of the area. Upon testing soil cores with drops of hydrochloric acid, we found that the transition between a very noticeable fizz to not seeing any reaction at all is abrupt. Carbonates detected around the top of the knoll were noticeably affected by elevation change (Figure 2). The soil data also shows that the calcareousness of the soil has a strong influence on both yield and grain quality above a certain level. Calcium carbonate equivalent (CCE) is the measure of the acid neutralizing capacity of a material relative to calcium carbonate and is expressed as a percentage, where pure calcite is a 100%. The sub-soil in the vicinity of Carrington is high in carbonates. The knoll in question seemed to have lost most of its top soil. Soil loss from a knoll or small hilltop is a natural process that can be exacerbated by frequent tillage. In 2018 and 2016 yield had a strong negative correlation with CCE values above 2%. Below 2% there was no significant effect (Figure 3 and 4). Similarly protein also had a strong positive relationship above 2% (Figure 5). Plumpness correlated negatively with CCE at that level (Figure 6). Both the high pH and the presence of carbonates inhibits phosphorus and micronutrient availability to the plants such as zinc, copper and iron. It is interesting to note that these more calcareous spots also had much higher residual nitrogen which positively correlated with CCE. Bulk fertilizer that was applied in the previous years has likely not been completely removed by the crops due to low yield potential, and the dry weather of recent years did not allow for significant leaching losses. Residual nitrogen correlated negatively with grain plumpness and positively with grain protein. Both of these correlations were much weaker than what the CCE values had with grain quality measures. From this we can infer, that while a higher nitrogen level in the soil may not have been at fault for lower grain plumpness, it also didn't help. For this reason, it would be advisable to limit nitrogen inputs on these calcareous eroded knolls.

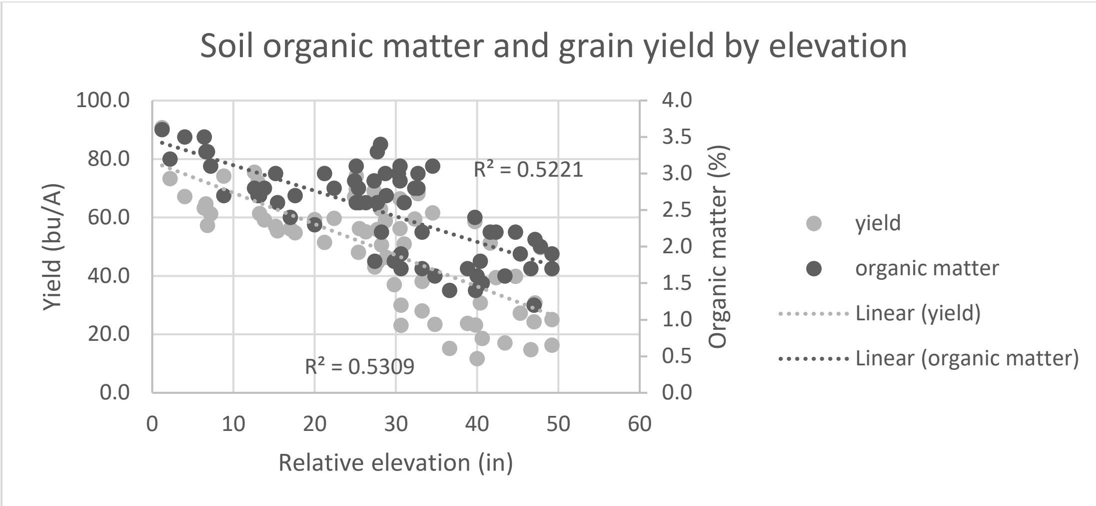

Figure 1. Soil organic matter content and barley grain yield by elevation relative to the lowest point.

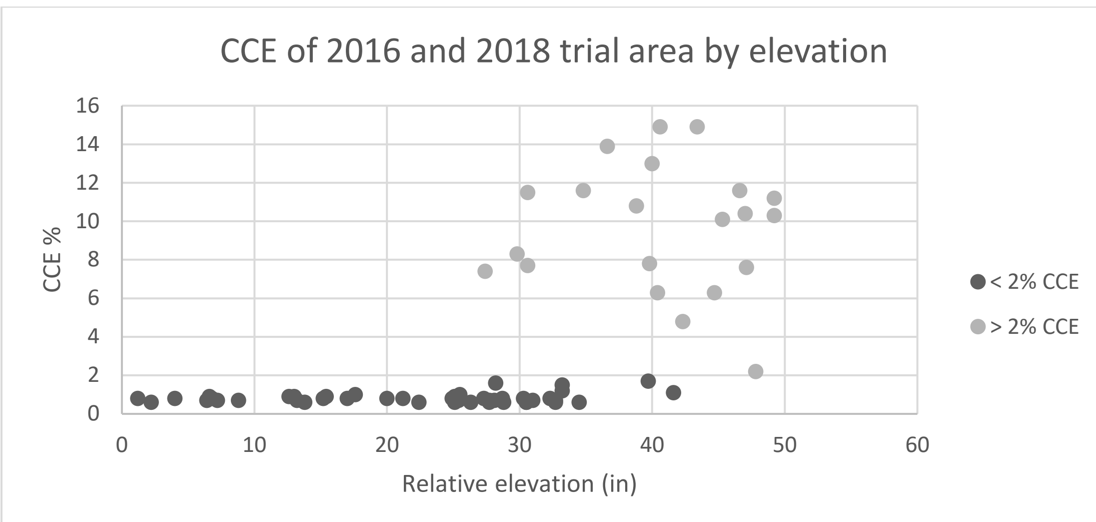

Figure 2. Calcium carbonate equivalent of soil from the 2016/2018 trial area by elevation relative to the lowest point.

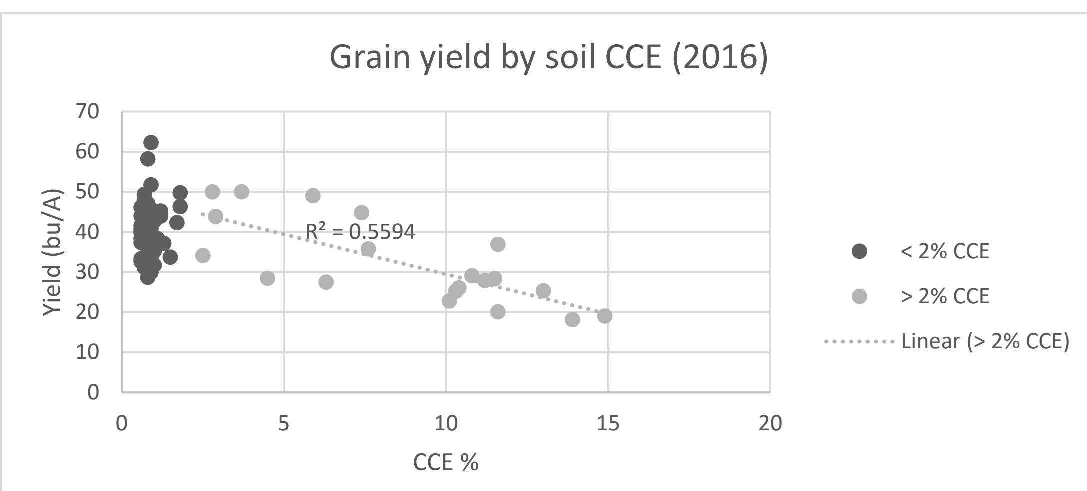

Figure 3. Barley grain yield by calcium carbonate equivalent levels of soil in 2016.

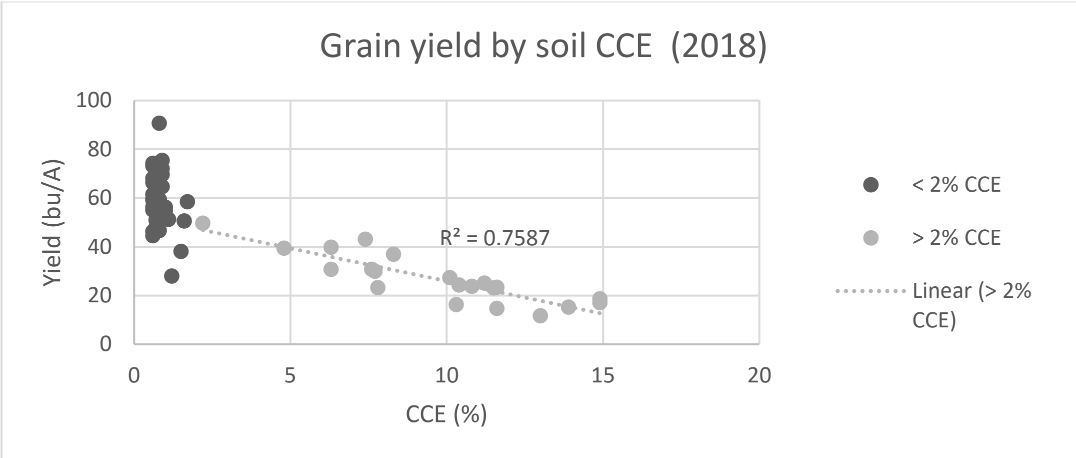

Figure 4. Barley grain yield by calcium carbonate equivalent levels of soil in 2018.

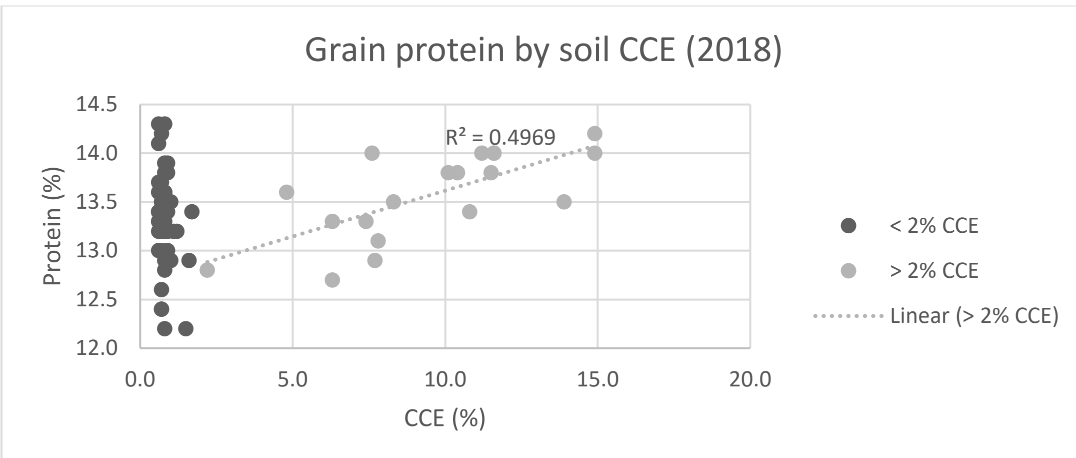

Figure 5. Barley grain protein by calcium carbonate equivalent levels of soil in 2018.

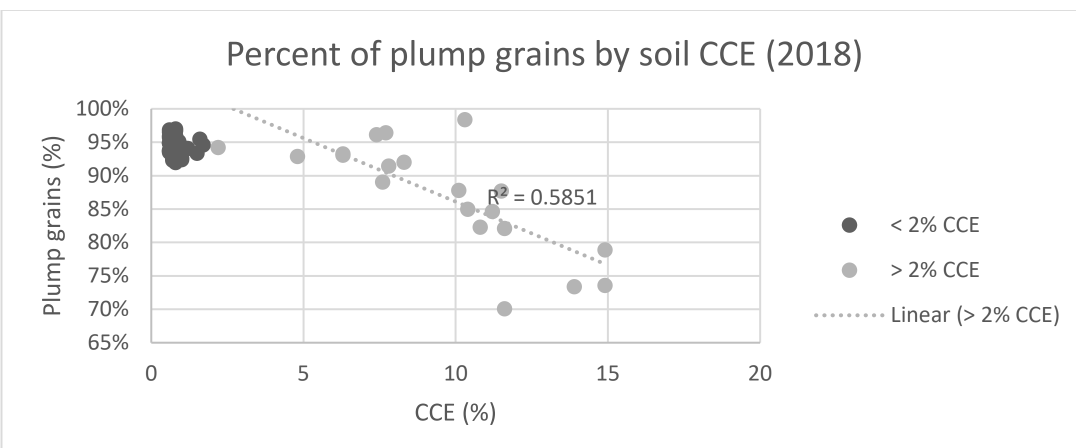

Figure 6. Percent of plump grains by calcium carbonate equivalent levels of soil in 2018.

With the advent of new technologies in the field of precision agriculture it will soon become possible to manage problem areas differently than the rest of the field. In our case it could be used to limit nitrogen use, and increase phosphorus and micronutrients. In other cases management can be tailored to saline spots. In any case a producer could, in theory create a soil map of his field and use that data for management purposes for many years to come. Also, given the yield limiting effect of high carbonate content in the soil, it could be important to map CCE in the field, even though it is typically ignored in soil tests.