Using Unmanned Aerial Systems for Site-specific Weed Management in Corn

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In 2017, corn was planted on 3.42 million acres in North Dakota (ND), with a production value of $1.3 billion (NASS-USDA, 2018). Therefore, factors that positively or negatively impact corn production in North Dakota can have a considerable impact on farmers' profit and on the state's economy.

A common agronomic practice for weed control on corn is to make two herbicide applications during the growing season. The first is usually made as a pre-emergence or soon after, and the second is usually made around growth stages V5-V6. The focus of this study is on the second application, which costs (product + application) around $15-20/ac. If one can use UAS (unmanned aerial systems) imagery to generate a weed distribution map for a corn field, a farmer could use such a map to make a decision to spot spray the field instead of making a blanket application across the whole field. Such an approach could save corn growers as much as $5-7 million annually with as little as a 10% reduction in applied acres. The objective of this study was to use UAS imagery to map and quantify weed infestation in corn for site-specific weed management during the second herbicide application.

Material and Methods

A 40-acre silage corn field at the Carrington REC was used for this study. Corn was planted on May 14, in a 30-inch row spacing. Our intent was to fly the field 1-2 days prior to the second herbicide application to create a "weed control prescription" map, which would then be programmed into our brand new 2018 model sprayer for site-specific weed control. Unfortunately, technical limitations with the sprayer and weather conditions forced us to revise our plan. According to the technical support, our sprayer could not shut the nozzles on and off based on a "weed control prescription" map. We flew two UASs with different sensors (multispectral and RGB sensors), at different heights, to test their suitability to produce an orthomosaic that could be used to detect weeds between the corn rows. For this study, the imagery collected with a Phantom 4 Pro (P4P), flown at 120 ft AGL (above ground level), showed to be more suitable for our purpose. The weed map was created using imagery collected on June 8. Our approach to map the weeds was basically look for plants growing between the corn rows. Once we determined the location of the center corn rows, we created a 6-inch buffer to each side. All the vegetation inside that area was considered to be corn plants and was deleted, leaving the weeds between the rows. To overcome the technical limitations of our sprayer, we created a grid cell (20 ft long x 30 ft wide) and intersected that with the weed layer (Figures 1 and 2). Every cell that contained at least one weed plant was sprayed, while the ones without weeds were not. The interface of the spray and no-spray cells were marked on the field using flags with different colors.

Weather conditions did not allow a second flight to map weeds or a spray operation close to the first flight date. The trial area was sprayed on June 15 using a 3-point tractor mounted sprayer (30 ft wide), turning the nozzle on and off manually as it moved across the field. The tank mix consisted of 1.3 pint of WideMatch + 28 oz. of glyphosate, applied at a rate of 13 gal/ac. We made 10 passes with the sprayer, and each pass was 48 cells long (around 6.6 acres total). The area adjacent to trial was managed as "business as usual" and it received a blanket application of the same mix and similar rate per acre. Corn silage was harvested on June 14-15, and we flew (120 ft AGL) the trial and adjacent field area with the P4P to assess weed coverage after harvest (Figure 2).

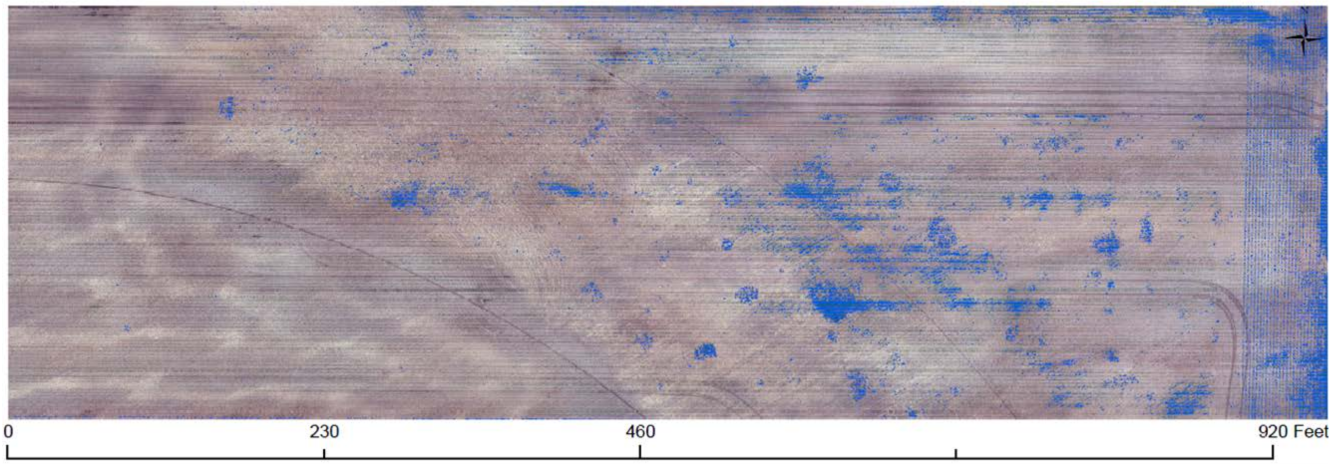

Figure 1. RGB imagery collected with a Phantom 4 Pro, at 120 ft AGL, on 06/08/2018, used to map weeds (in blue) on silage corn field.

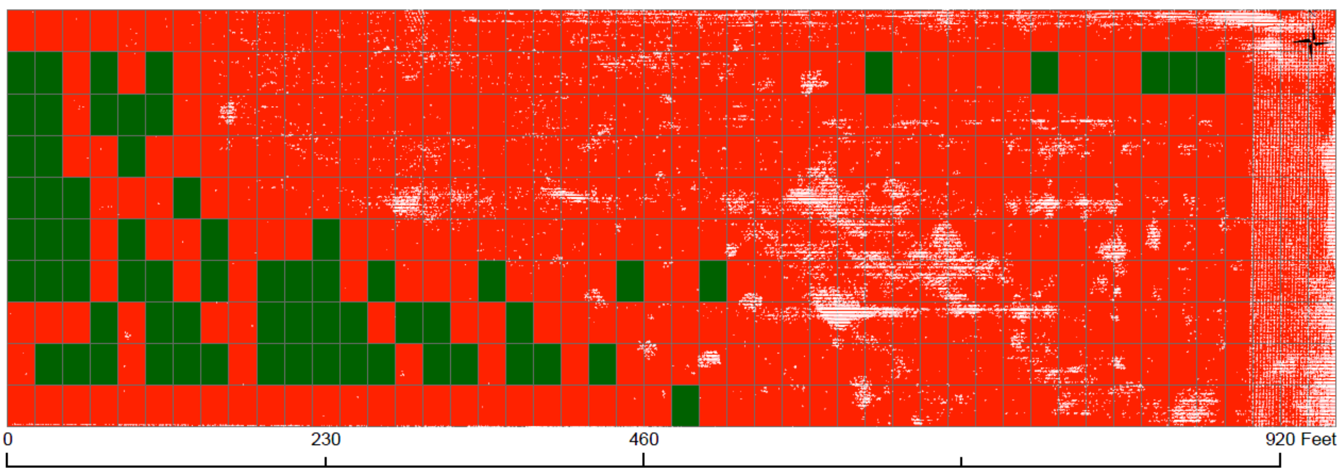

Figure 2. Grid (20 x 30 ft cell size) overlaid on top of the RGB imagery and intersected with the weed layer (white). Red= spray and Green= no-spray.

Results and Discussion

The P4P flying at 120 ft AGL yielded an orthomosaic with average ground resolution of 0.36 inch/pixel, which allowed us to map the weeds growing between the corn rows (Figure 1). On the east end of the field, one can notice several rows, oriented north-south, misclassified as weeds. Those are actually corn plants, which were planted perpendicular to the rows orientation in each end of the field. We did not spend time trying to correct that because there was a large infestation of weeds in that area, which warranted spraying those cells.

By intersecting the weed layer with the 20 x 30 ft grid cell, there was a reduction of 16% (89 cells out of 461) of the area to be sprayed (Figure 2). That can be of great value for corn growers, since it can result in savings for chemicals and decrease the amount of those chemicals applied to corn fields (environmental benefit). Using the same weed data layer and by decreasing the grid cell size to 10 x 10 ft or to 3.28 x 3.28 ft, the area not sprayed would go up to 40% and 70%, respectively. That shows that such an approach for weed control can potentially have a large impact on both economic and environmental aspects of corn production.

Figure 3 shows the percent weed coverage after corn silage harvest. There were only three (out of 480) cells that showed weed ground coverage higher than 3 percent, and those were cells that were sprayed earlier in the season. The cells that were not sprayed showed similar levels of weed infestation to the vast majority of cells sprayed in the trial area and in the area adjacent to it. The area adjacent to our study received a blanket application with the same products and rates applied to our study, which were applied using the sprayer that we first intended to use for this study.

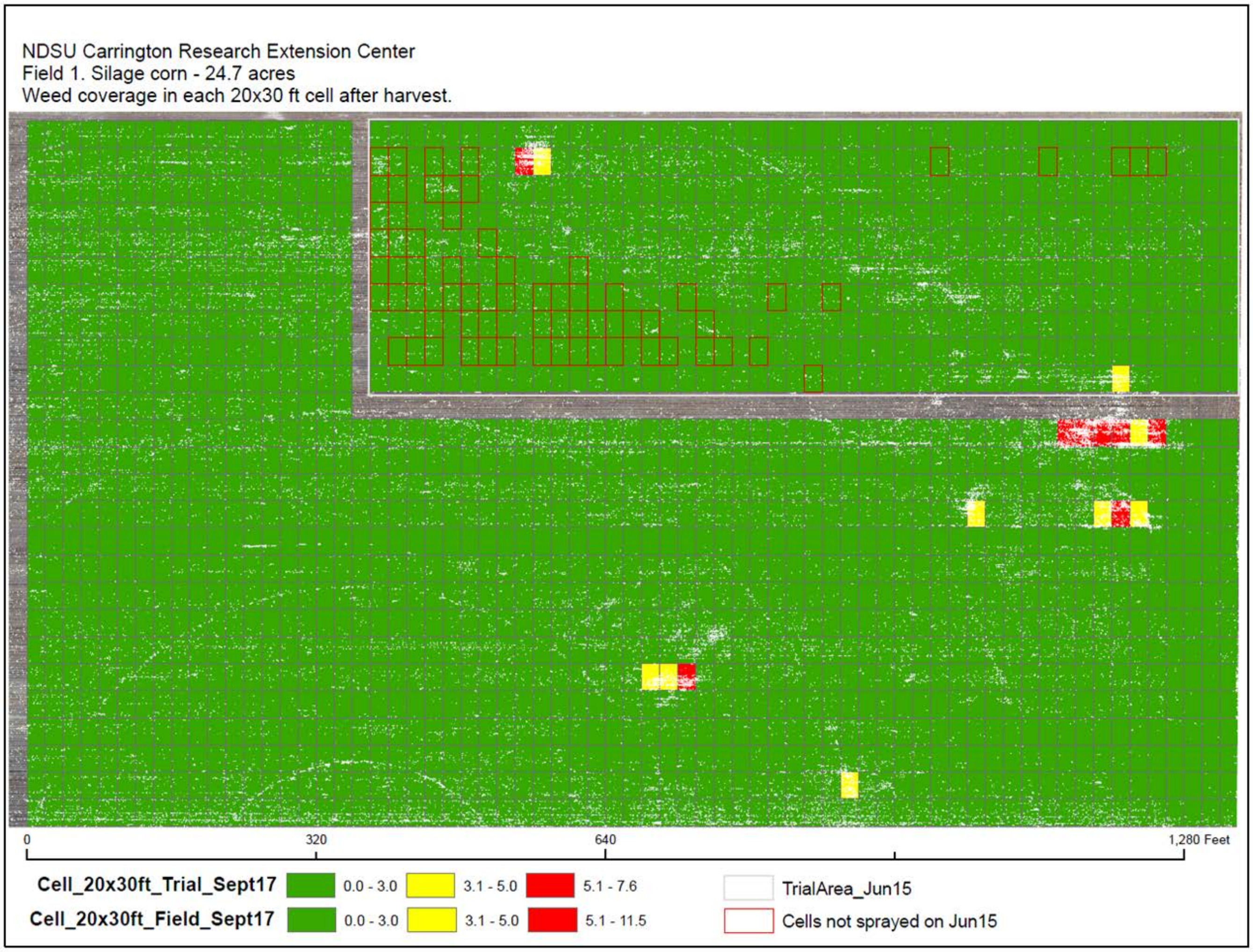

Figure 3. Percent weed coverage in each grid cell (20 x 30 ft) projected on top of the RGB imagery collected on September 17, 2018, (Phantom 4 Pro, 120 ft AGL) from the both study area (gray box) and the area adjacent to it.

Based on our results, the use of UAS imagery for site-specific weed control on corn has the potential to generate savings for corn growers by decreasing the area that needs to be sprayed. In addition, there is a potential to decrease the environmental impact of corn production as well, since the approach reported here would lead to less chemicals being applied to corn fields. Those benefits can be increased by the use of sprayer technologies that can automatically handle chemical applications to grids with small cell sizes.