

USU Extension Grant – Final Report

Project leader: Claudia Nischwitz

Project title: Drones in Agriculture: Early disease detection, yield estimates and other applications

Beginning Date and End Date: June 1, 2016 – May 30, 2017

Total requested: \$6,079

Project summary:

Unmanned aerial vehicles (UAV) are increasingly used in agriculture. This project demonstrated the benefit of the use of UAVs in Utah agriculture (detection of planting problems, diseases, yield estimation and yield loss) and interested growers and farmers were able to attend a workshop to get more information on types of UAVs, cameras and costs. In addition, workshop attendees were able to fly an UAV at the research farm and learn hands-on to use software to analyze images.

Project results:

- a) After attending the workshop Mike Pace (Box Elder county Extension Director) expressed interest for future collaborations. Due to time conflicts with another meeting, no other Extension agent was able to attend. There may be additional interest after the brief presentation and the poster at the 2017 USU extension conference.

- b) In August 2016, Dr. Nolte and his technician, the collaborators from the University of Arizona, came with their UAVs and we flew over six commercial fields and two of my vegetable trials at the Kaysville research farm. The commercial fields had peppers, tomatoes, zucchini, onions, beans and sweet corn. My trials had onions, summer squash, eggplants and bell peppers. The tomatoes were infected with Tomato spotted wilt virus, the sweet corn had High plains virus and the onions in my trial had Iris yellow spot virus. The peppers in commercial field were infected *Candidatus Liberibacter solanacearum*. The zucchini field showed uneven growth of individual plants and was used for yield estimates. In contrast to my onion trial the commercial onion field was transplanted resulting in the onion bulbs being above ground allowing for bulb counts and yield estimation. We then analyzed the pictures after stitching them together using the free software Image J.

It was very easy to find the pepper plants infected with *Candidatus Liberibacter solanacearum* in the image. The plants were extremely stunted and easily distinguished from healthy plants in the field. The images also allowed us to see planting gaps in the field. There were 15ft sections on planting beds without any plants. Flying an UAV over the field a few days after planting would allow a grower to go back and put plants in the sections that were missed. Based on information on the number of bell peppers per box we were able to estimate how much loss a grower would have because of the missing

plants in the 15ft section. Depending on the size of the peppers the loss in yield would range from 1.5 – 4.5 boxes.

The corn had been planted four weeks prior to the flight. For corn it is important to fly early before healthy plants overshadow diseased or struggling plants. HPV is commonly spread by wheat curl mites from grasses in ditch banks or wheat to corn and vice versa. Occasionally, as was in this case it can be seedborne. The infected plants were stunted and had chlorotic to almost white leaves. Many infected plants never grew more than 1.5ft in height. Using the Near-IR camera the infected plants were clearly visible in the image. The green healthy tissue was red and the chlorotic tissue of infected plants stayed white. It also confirmed the suspicion of the virus being seedborne by the pattern we saw in the field.

We were unable to use the Near-IR for IYSV and TSWV detection. A regular light camera or thermal camera may be more useful for these diseases. In addition, the tomato field had a lot of weeds that made it difficult to see the tomato plants.

In my squash trial it was easy to see the irrigation problems we had with plants towards the end of the rows being a lot smaller than plants at the beginning of the row. To determine if we could use plant size at a given time for yield estimate of zucchini, we had selected five large plants and five small plants in the commercial field that were monitored for five weeks after the flight had taken place for marketable zucchini. Counting the number of zucchinis developing on the plants it was very clear that the larger plants at the time of flight develop more marketable fruit than the small ones. In size, the larger plants had 3.5 times the area of the smaller plants and had on average five marketable zucchinis per plant. The smaller plants, even though by the end of the evaluation period they had about the same size as the plants that were larger in the beginning, only had two marketable zucchinis per plant. This information can be used in the future to develop algorithms that could allow yield estimates for an entire field early on.

The transplanted onions had bulbs that were completely above ground making it easy to see them. In the Near-IR they stay white while the green leaf tissue is read. Using a counting function in ImgaeJ and knowing the area of the field, the individual bulbs can be easily counted and yields estimated several weeks prior to harvest.

For the workshop in November we had 12 attendees including growers, ranchers, arborist and Extension personnel. The attendees were provided with handouts of the presentations and software for image analysis. The attendees were very interested in learning about the different types of UAVs, cameras and uses. Everybody was able to fly one of the UAVs at the research farm and in the afternoon we had a hands-on part to use the free software for image analyses. We received very positive feedback from attendees and many said that they plan on purchasing an UAV. Several attendees stayed long after the workshop ended to ask questions for specific uses (including applying pesticides and fertilizers using UAVs and finding lost cattle).

- c) An Extension fact sheet will be published on the use of UAVs for detecting field problems and yield estimation and posted to the USU extension website. A poster with the results of the project will be presented at the American Phytopathological Society meeting in San Antonio, TX in July 2017.

- d) At the 2017 USU Urban and Small Farms conference a survey will be conducted to determine the interest for additional workshops. If there is sufficient interest, we will apply for a Specialty Crop Block grant to conduct additional workshops in Southern and Northern Utah.

Presentations

A presentation on the application of drones in agriculture will be given at the USU Plant Pest Diagnostic Lab In-service training at the 2017 USU Extension conference as well as at the USU Urban and Small Farms conference. After the In-Service training the presentation will be posted to the Utah Plant Pest Diagnostic Lab where it will be available for everybody.