Sunflower Stand Counts from Imagery Collected with a Small Off-The-Shelf UAS

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Establishing a uniform stand when planting sunflower has been one of the more challenging factors when managing the crop to optimize performance. Achieving evenly spaced sunflower plants can be difficult due to the inherent size, shape and weight of the seeds. Evenly spaced plants or singulation is the goal when planting, however sunflower stands often include gaps (skips) and doubles (plants too close together). A stand establishment trial was conducted in 2017 to evaluate different factors that may impact the ability to enhance sunflower seed spacing at planting. This trial was utilized to develop a methodology to perform sunflower stand counts early in the growing season using UAV imagery and GIS (Geographic Information System) software.

Material and Methods

Sunflower plots (50 ft long by 30 ft wide) were planted on May 25, 2017 with a 30-in. row spacing. Stand counts in the field were conducted on June 7, 8, 9 and 12, 2017, by counting the number of plants on four pre-selected 30 ft long rows in each plot. On those same dates, plus June 16, a small UAS (unmanned aerial system) (Phantom 4 Pro) was flown to collect imagery from the experimental area. The Phantom 4 Pro is an off-the-shelf, ready-to-fly quadcopter, fitted with a 20.1 megapixel camera. Missions were flown at 45 ft above the ground level. The images collected were processed with Pix4Dmapper Pro by Pix4D. The resulting orthomosaic had a ground resolution of around 0.1 in/pixel. That resolution allowed for clear observation of individual sunflower plants, with few exceptions.

For this study, the field stand count data and UAS imagery collected on June 12 was used, plus UAS imagery collected on June 16. Using tools in ArcGIS 10.5 software and the UAS imagery, we were able to develop a computer workflow to perform stand counts on the same rows evaluated on the ground. To evaluate the accuracy of our computer model approach, we compared the ground stand count with the stand count obtained by our methodology. The ground stand count for June 12 was obtained by visually counting the plants in the field, while for June 16 it was obtained by manually counting the plants on the UAS imagery. The UAS imagery from both dates was used to count and locate “doubles” by either visual observation (overlapping plants, 2+ plants) or distance (less than 4 inches between plants). The location and number of doubles play a crucial role in the accuracy of our method.

Results and Discussion

Figure 1 shows the location and distribution of doubles (by visual observation [VO] and distance) across the experimental area. As one can observe, there are rows with no doubles while others have a considerable number of them. As shown in Figures 2 and 3, the occurrence of doubles has a big impact on the accuracy of the computer model. On June 12, the number of doubles by distance was higher and the number of doubles by VO was lower than on June 16. That is because on the earlier date the plants are still small and do not overlap each other, so the software can segment the plants individually. However, four days later, the closest plants were overlapping each other and were counted as doubles by VO, decreasing the occurrence of doubles by distance (Figure 1).

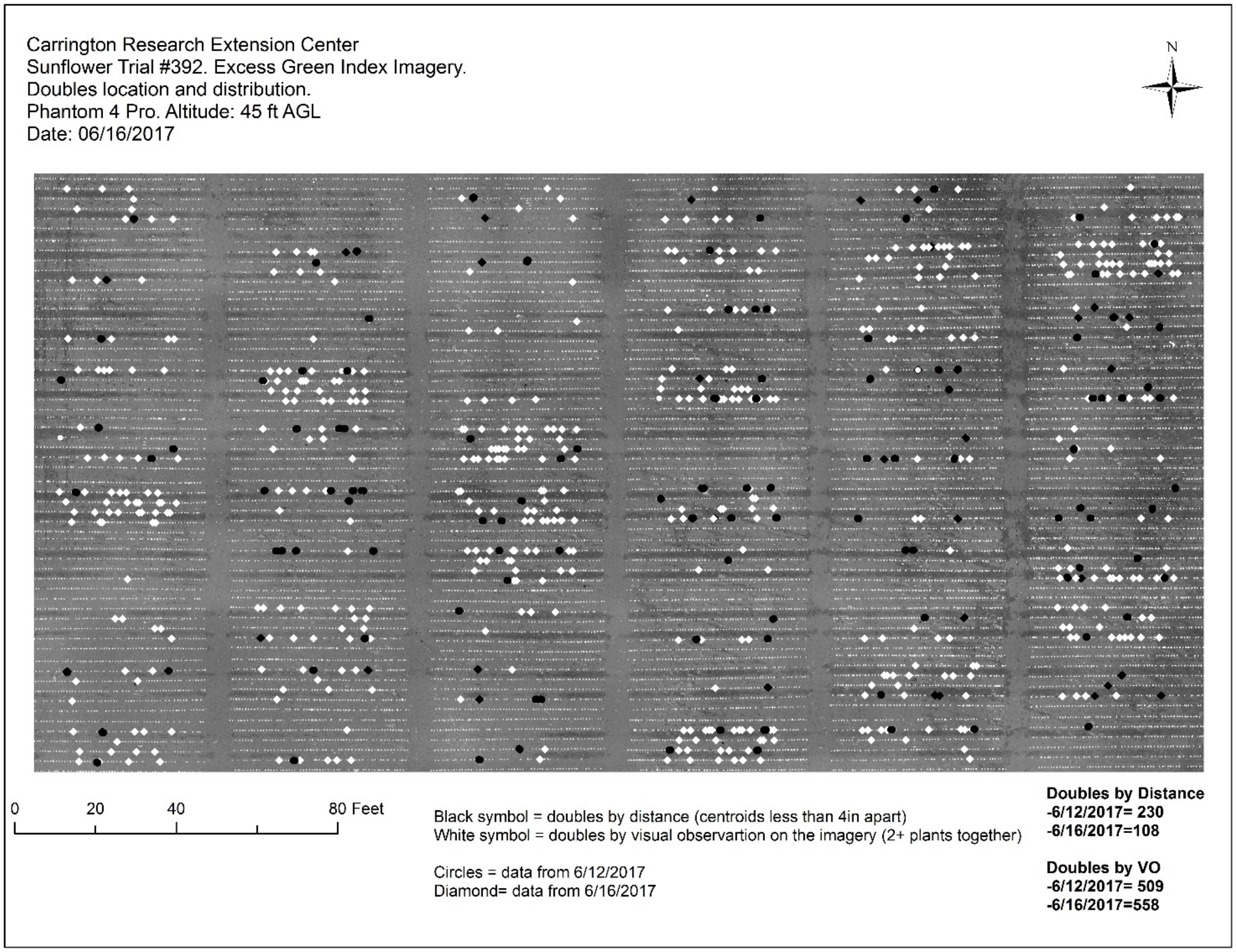

Figure 1. Doubles location and distribution on a sunflower trial at the Carrington REC. Imagery collected on June 16, 2017 at 45 ft above the ground.

Figures 2 and 3 show the correlation between the plant stand either from the field (Figure 2) or by direct stand count on the UAS imagery (Figure 3) and the plant stand obtained from the UAS imagery using ArcGIS software. In both cases, one can see that the correlations between the data from visual counting and the computer stand counting is greatly improved when the rows with doubles were removed from the dataset, in which case both methods yielded very similar stand counts for both dates. We made an attempt to take into consideration the occurrence of doubles, but due to the non uniform size of the plants and the occurrence of doubles with 3-4 plants, that approach did not work well. The same approach seems to work well when there were few doubles per row and they were made up of only two plants.

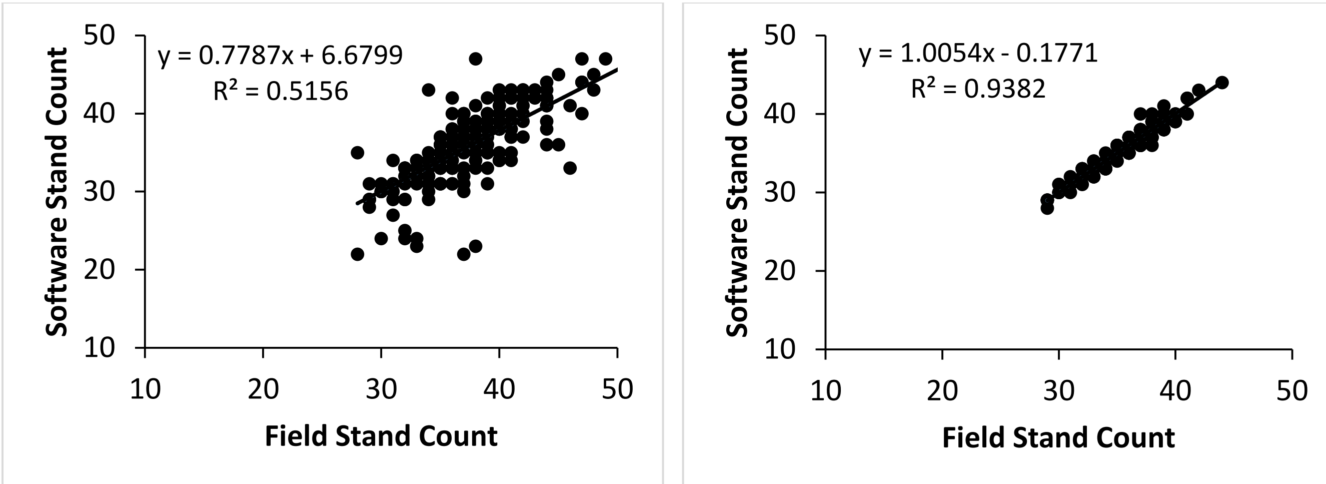

Figure 2. Correlation between sunflower stand count in the field and count made using UAV imagery and ArcGIS, before (left) and after (right) adjusting for doubles (128 sunflower rows).

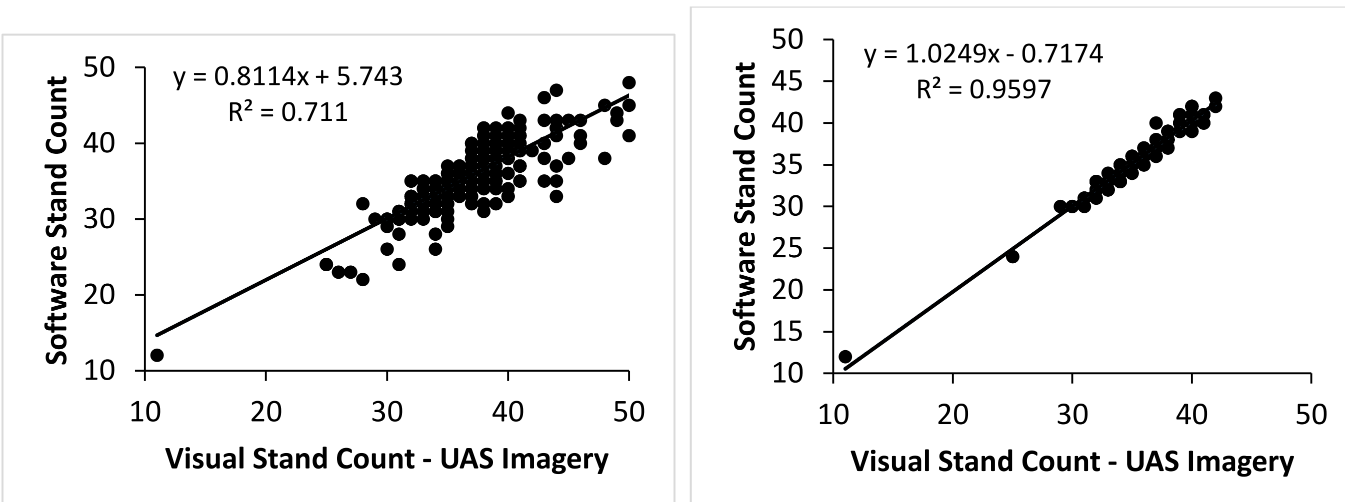

Figure 3. Correlation between sunflower stand count done by visual observation on UAV imagery and by using ArcGIS, before (left) and after (right) adjusting for doubles (135 sunflower rows).

Based on the results found in this study, given that the UAS imagery has adequate spatial resolution, we are confident that our methodology can accurately perform stand counts on sunflower fields established with adequate singulation. One factor that needs to be improved is the approach for determination of the rows, which will allow us to easily apply our methodology to large commercial fields. In addition, a similar approach can be used to perform stand counts on other crops, such as corn.