High throughput phenotyping for assessment of bacterial blight in field pea

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Bacterial blight is a major disease of field pea that causes significant yield losses worldwide. Breeding resistant cultivars is crucial to minimize yield losses from this disease. Employing high throughput phenotyping methods in breeding programs can save significant time and efforts when assessing the disease across larger breeding trials. In this study, an unmanned aerial vehicle (UAV) mounted with multispectral camera (Micasense Red Edge) was used to acquire images that were processed to generate normalized difference vegetation index (NDVI) from five co-located field pea breeding trials (stage 0 to stage 3 trials and PHISTHO18) at Horsham in 2018. A handheld device Crop Circle™ (ACS 470, Holland Scientific, USA) was used to record NDVI scores from two trials (stage 2 and PHISTHO18) in 2-15 days interval from 27th August to 5th December. Visual scores bacterial blight disease were also recorded on a 1-10 scale (1=resistant, 10=susceptible) from all the trials. Yields were obtained from machine-harvest of the whole plots. Yield losses were assessed for four check varieties present in all the trials. The check varieties had different levels of disease resistance; PBA Percy (moderately resistant, MR), PBA Oura and PBA Butler (moderately resistant to moderately susceptible, MRMS), and Kaspa (susceptible). Yield losses were estimated as the percentage yield loss in the plot most affected by the disease compared with the one least affected by the disease. The yield losses were, Kaspa 55%; PBA Butler and PBA Oura 22 and 37%, respectively; and PBA Percy 32%.

NDVI had significant positive correlations (r = 0.39 to 0.778) with plot yield and significant negative correlations (r = -0.39 to -0.73) with visual scores of the disease in all the trials except in the stage 3 trial. Correlation analysis of NDVI recorded with Crop Circle™ at different times showed that the NDVI recorded on 16th October had the strongest correlations with plot yield and visual scores of the disease in stage 2 and PHISTHO18. The second half of the September suffered from multiple frost events with a cumulative 62 hours of below 0° C temperatures. Strongest correlations of NDVI on 16th October with plot yields and visual scores of the disease possibly was a result of the frost events which consequently exacerbated the disease. Frost driven bacterial blight epidemic is evident from strong correlations among NDVI scores measured on 16th October with plot yields and visual scores of the disease.

The results clearly demonstrated that susceptible varieties suffered substantial yield loss compared with the MRMS and MR varieties in field conditions. In summary, NDVI captured bacterial blight disease scores and could be used as high throughput phenotyping technology to assess the disease in breeding trials.