Lentil sensitivity to frost and rapid detection in field using proximal sensors

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Radiant frost limits production and export value of lentil in southern Australia, by reducing grain yield and quality. Increased understanding of the impact of frosts, including severity and growth stage effect will enable effective management and limit associated financial losses. Further, non-destructive measurements (handheld, UAV or satellite imagery) would be useful to assess the extent of frost damage at paddock scales ahead of harvest. To address these research gaps, active frost treatments were applied to field grown lentil at different intensities, using mobile frost chambers, at Horsham (2017) and Ouyen (2018), Victoria. Experimental work in 2017 assessed the response of lentil (cv. Jumbo 2) to 12 frost scenarios, where temperatures below 0°C were applied at; flowering, early pod, flat pod, filling-filled pod. This study determined that lentil was most susceptible to frost during the pod filling stage, where for every degree hour below zero, there was a 2% reduction in grain yield. This compared to the response at flowering, where a threshold of 31°C.hr (<0°C) was reached prior to yield reduction, and thereafter yield decline was 3.8% per °C.hr. Experimental work in 2018 (Ouyen) was expanded to assess if Group B herbicide (imidazolinone (imi)) tolerance in lentil was linked to increased sensitivity to frost. Frost was applied at the late vegetative and late podding stage, where four imi lentil varieties (PBA Herald, PBA HurricaneXT, PBA HallmarkXT, CIPAL1721) and two conventional lines (PBA Jumbo 2 and PBA flash) were tested. Under applied frost conditions (severe), conventional and imi lines were equally affected by frost during the late vegetative and reproductive period. This result infers that the increased visual symptoms of frost damage in imi tolerant lines (e.g. PBA Hurricane XT) observed by industry, is unlikely to translate to greater yield loss due to frost. As part of these trials, proximal sensing was used to monitor the crop. A handheld active light fluorometer was used to measure SFR_G, an index related to chlorophyll concentration. Spectral reflectance of the canopy was used to determine the Normalized Difference Vegetation Index (NDVI) and the Photochemical Response Index (PRI). The results show that in addition to the proximal measurements detecting natural senescence occurring during the period from flowering to pod fill, it also detected a decrease in canopy chlorophyll associated with cold exposure, beyond a threshold cold sum value (5 – 31ºC.hr). NDVI from canopy reflectance measurements was related to cold sums across pooled measurement dates with an R^2 value of 0.81. The reflectance index PRI increased with increasing cold exposure (R^2 value of 0.61), indicating changes in photosynthetic efficiency with increasing frost damage. SFR_G from the active fluorometer measurements was related to cold sums with an R^2 value of 0.84 six days following frost application at flowering, and 0.72 eight days following frost at pod filling. Next steps will include assessment of other sensors, additional growth stages, and response to frost for other lentil varieties.