Do sensors explain the advantage of navy bean intercropped with maize under limited water and N environments?

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Abstract

Sensor technology has been widely used under field conditions to improve our understanding of crop stress level to a wide range of production factors. Here we used active and passive sensors, such as infrared thermometer, SunScan canopy analysis system and neutron moisture meter to understand the physiological and environmental drivers of navy bean-maize intercropping advantage as the level of water and N input decreases. Field experiments were carried out at Gatton research station of the University of Queensland in 2011/12 and 2012/13 summer seasons. Navy bean – maize intercropping systems and their sole crops were evaluated using automatic rainout shelters in three trials viz., under low water/nitrogen (W/N), medium W/N and high W/N conditions. Sensors were deployed to quantify the aboveground and below ground production factors, viz., plant available soil water, fraction of intercepted photosynthetic active radiation (fPAR), relative humidity and temperature both inside and outside canopy of sole and intercropping systems. Canopy stress index as well as productivity index viz., Land Equivalent Ratio (LER), were computed to assess the stress level of component crops and grain intercropping advantage gained over their sole crops. Resource use (i.e. water, nitrogen and light) and use efficiency were analysed in both intercropping and sole cropping systems. The result indicated that the higher the level of water and nitrogen, the lower the advantage of intercropping system in terms of LER. Under low water and N input, intercrop navy bean had lower canopy temperature and stress index values compared to sole crops. In addition, intercrop system intercepted significantly higher fPAR than both sole crops for long growing period under limited water and N availability. The intercropping advantage (in terms of LER) was directly related to the intercropping advantage on system's water use efficiency (not to water use) and system's N use (not to NUE). However, there was no clear relationship between the intercropping advantage (in terms of LER) and radiation intercepted or use efficiency. Overall, this research has demonstrated that sensors appear to be more applicable in explaining factors driving intercropping advantage as the level of water and N availability decreases. From this finding, it seems that intercropping of navy bean with maize might have maintained navy beans temperature in a water stressed environment. Further research efforts should be needed to automate the sensors we used for applications at a larger scale in pulse based cropping system.