Soil water deficit under switchgrass during the 2017 growing season

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Background

- Biomass production for cellulosic ethanol depends highly on soil water availability, even in Michigan's humid climate.
- Selection of bioenergy crops considers information on crop water demand and water use efficiency for biomass production.
- Switchgrass has been identified as a candidate crop for ethanol production.
- Southern Michigan has experienced two strong drought periods recently, one in 2012 and other one in 2017, where summer temperatures were exceptionally warmer than average, and precipitation was 50 percent below normal resulting in extreme soil dryness.
- Drought map indicates abnormal dryness or drought for most of southern Michigan (Fig 1).
- It is not fully known if conversion of land use to bioenergy crops can alter the landscape hydrology.

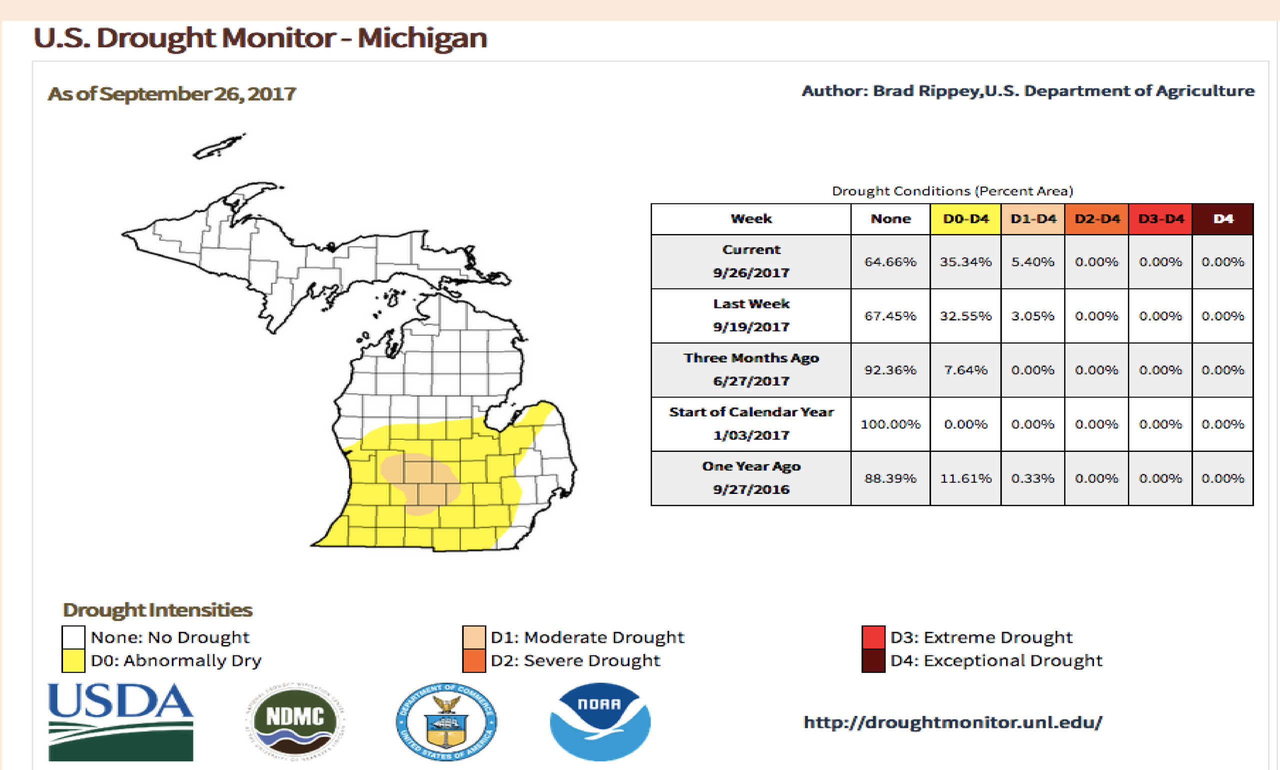

Figure 1: U.S Drought monitor for 27 September 2017

Materials and Methods

Continuous monitoring of soil water under switchgrass has been conducted since 2009 at the GLBRC Biofuel Cropping System Experiment (BCSE) at W.K. Kellogg Station (Fig 2).

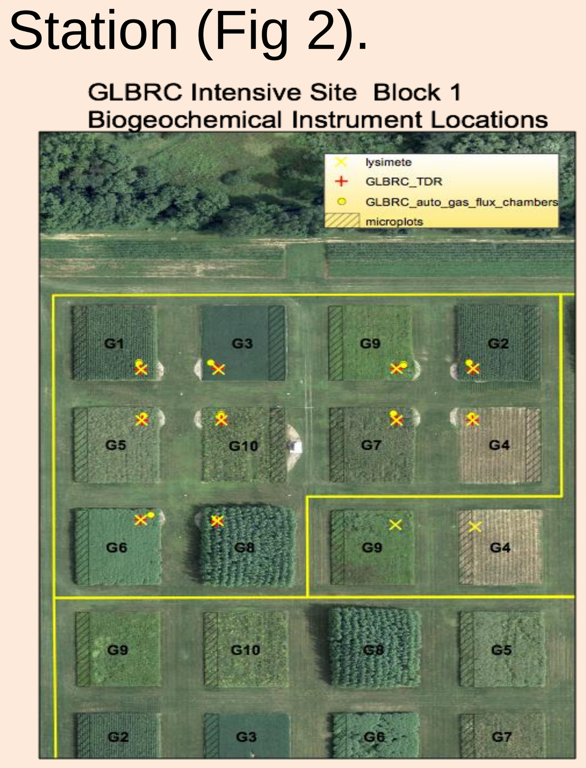

Figure 2: GLBRC intensive field site at KBS, Michigan (G5 plot is Switchgrass)

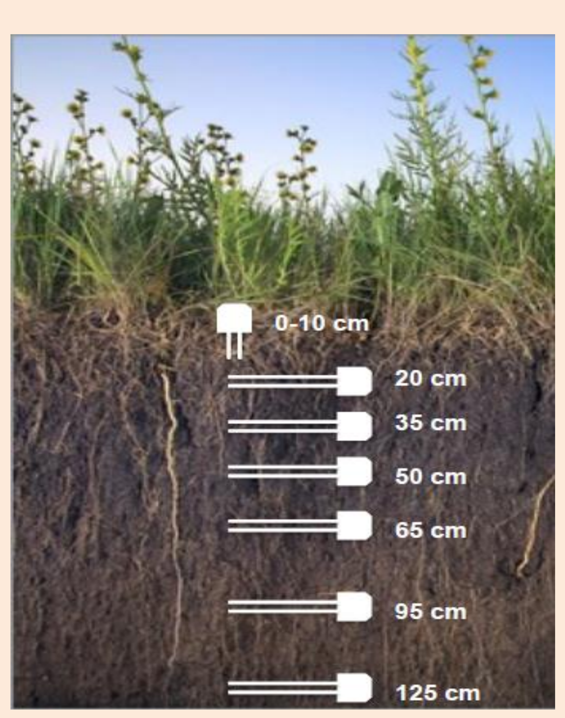

Figure 3: Installation of TDR probes

Soil moisture measurements

- Time Domain Reflectometry (TDR) probes were installed at different soil depths (up to 125 cm) (Fig 3).
- Volumetric soil water content (v/v) measured at 60 minute intervals.

Processing of soil water data

- Processing and handling of raw data have been described in Hamilton *et al*. (2015).
- Converted the SWC (v/v) to equivalent water depth, ESWD (0-150 cm soil depth).
- Estimated the drained upper limit (DUL) and lower limit (LL), and plant-extractable SWC (PESW) as DLL-LL.
- Calculated the Soil water deficit (SWD) as the difference between mean DUL and ESWD.

Results

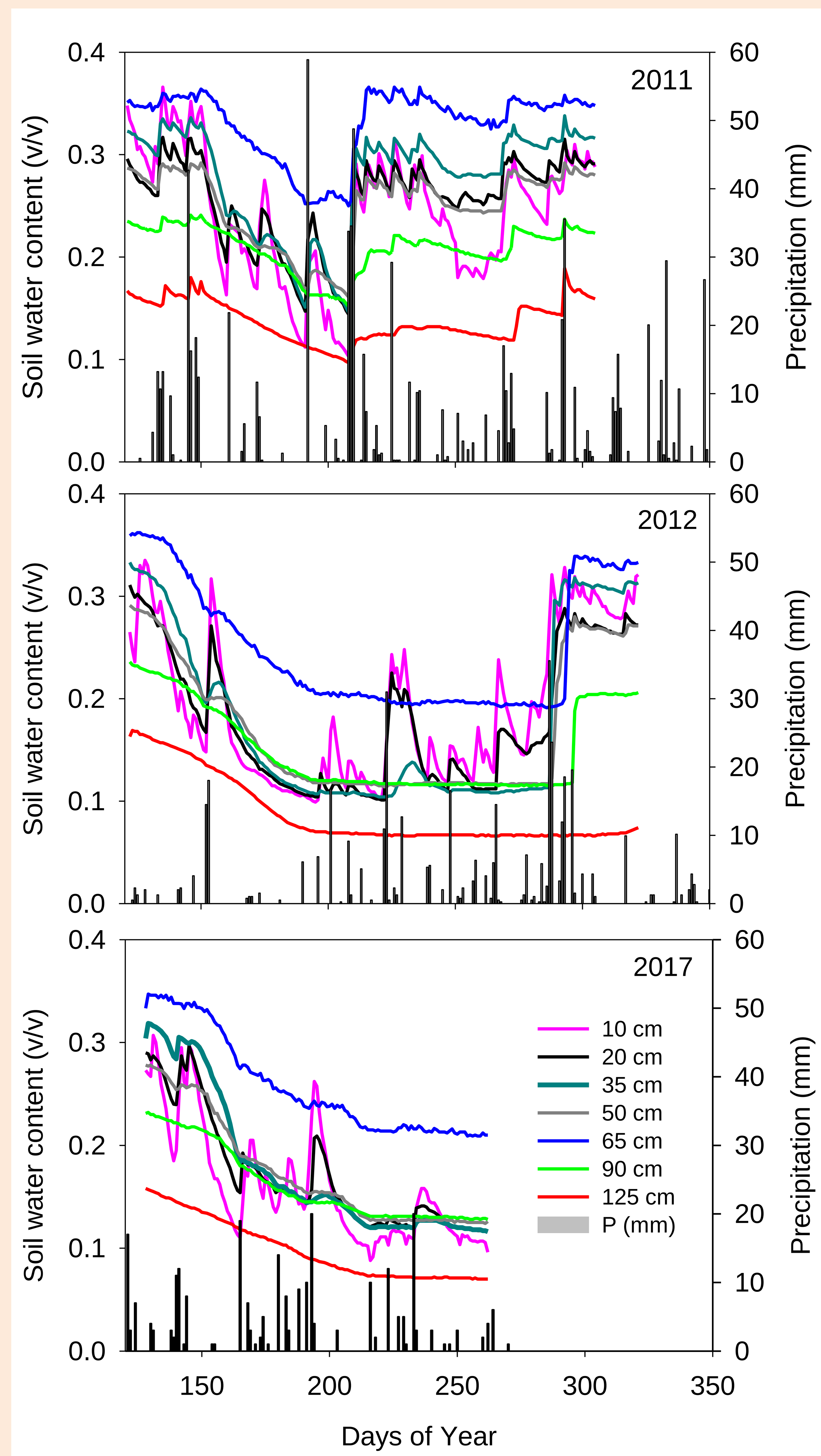

Figure 4: Soil water content (v/v) measured under switchgrass at different soil layers during normal (2011) and drought years (2012, 2017)

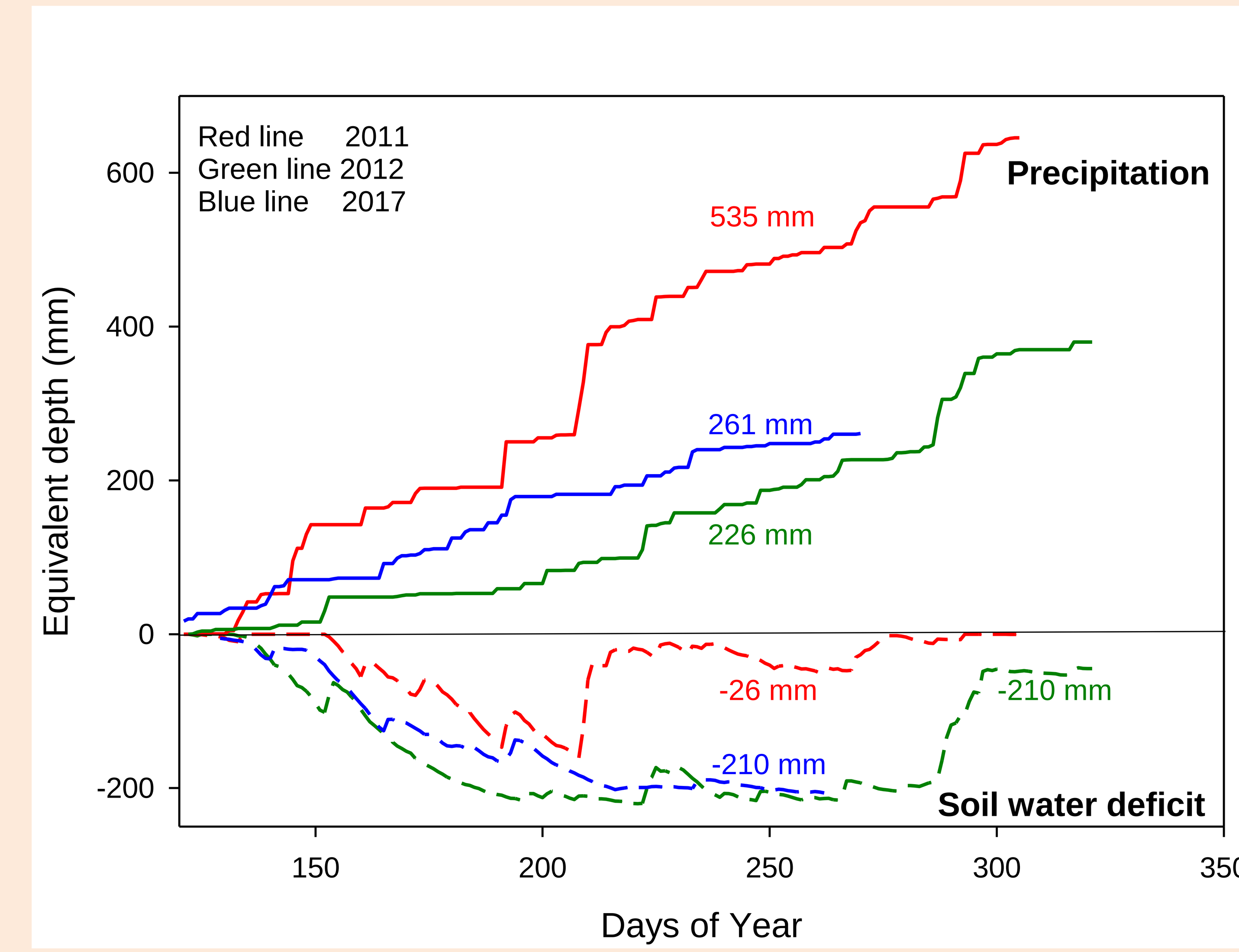

Figure 5: Cumulative values of precipitation and soil water deficit under switchgrass during normal (2011) and drought years (2012, 2017) for the period 1 May to 26 September. Negative sign indicates soil water deficit relative to its fully wetted state. The number of growing days varied from 193 in 2011 to 180 and 163 days, respectively, in 2012 and 2017.

Discussion

- Compared to 2011, 2012 and 2017 had abnormally dry soil conditions as a result of warmer temperatures (data not shown) and little new rainfall.
- In 2011, the soil profile was recharged by frequent and larger rainfall events as compared to insignificant recharging in 2012 and 2017 due to less frequent and smaller rainfall events (Fig 4).
- Deeper soil layers were consistently drier in 2012 and 2017 and soil moisture content fell below 10 percent.
- During the 2012 and 2017 growing seasons, the soil water deficit leveled out at ~200 mm, the lowest that the plants can draw it down (Fig. 5).
- The 2017 growing season has been nearly as drought-stressed as 2012, but a few modest rain events early in the growing season appear to have maintained crop productivity at a higher level in 2017 than in 2012.
- Yield data are forthcoming.

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