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# Plant Available Water Capacity (PAWC) for Deep-Rooted Crops in Cracking Clay Soils (Vertisols) of Semi-Arid Central India

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***Abstract:*** *Smectite is the dominant clay mineral in the cracking clay soils (mainly Vertisols) in the semi-arid tropical (SAT) region (Vidarbha and Marathwada).Amongst the crystalline clay minerals, smectite has the highest soil moisture retention capacity depicted as the available water between field capacity and wilting point, which increases with soil depth. But in SAT Vertisols of Vidarbha and Marathwada regions, the release of this soil water is unavailable to deep-rooted crops, causing loss of crop yield is frequently observed. Thus, the water holding between33 and 1500 kPa tension is not in reality available soil moisture in these soils. The release of soil moisture is, however, seriously constrained by the dispersion of smectitic clay colloids due to the presence of both Mg and Na ions on soil exchange complex. In reality, in calcareous Vertisols of non-sodic nature, soil moisture is held at 100 kPa while in calcareous Vertisols of sodic nature it is held at 300 kPa. Based on this field observation the concept of plant available water content, which relates to profile water content, was adopted earlier to calculate the plant available water capacity (PAWC) considering the soil moisture held between 100-1500 kPa for non-sodic and 300-1500 kPa for sodic soils. This pragmatic PAWC method showed a significant positive correlation between the PAWC and the yield of cotton (lint + seed) of 32 Vertisols of the Vidarbha region, however, it did not address the status of soil moisture release at higher tensions. It is apprehended that at higher tensions, the release of soil moisture is not enough during the dry period of the season that can prevent the extension of vertical cracks in the slickensided horizons at deeper depth of 100 cm and beyond. Less amount of soil water in the subsoils is due to the decrease of saturated hydraulic conductivity(sHC) with depth preventing the free flow of rainwater in the subsoils. This makes subsoils as more water constraint horizons but enriches subsoils with pH > 8.0, more amount of $Mg^{2+}$ and $Na^{+}$ ions on soil exchange complex. Such Vertisols do not support the second crop during the winter months. In view of this predicament in agricultural land use plan of SAT Vertisols, the present study was undertaken to understand the cause and effect relationship between soil moisture and relevant soil parameters that prevent the release of soil moisture at higher tensions. In order to find an insight into this queer issue, soil moisture retention and release curves at 33, 100, 300, 500, 800, 1000 and 1500 kPa, were obtained for each genetic horizon of 33 representative Vertisols of Vidarbha and Marathwada region. In Vidarbha, Vertisols are Aridic/Typic/Sodic Haplusterts and Calciusterts, and in Marathwada, they*

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*are Typic/ Sodic Haplusterts. Moisture tension curves indicate that the release of water beyond 800 kPa is negligible. Failure in the release of soil water beyond 800 kPa is due to the dispersion of fine clay size smectite (< 200 nm) consisting primarily of nano-size smectite (<100 nm), caused by the $Mg^{2+}$ and $Na^{+}$ ions present on the soil exchange complex. The dispersed nano-size smectite blocks the macropores and simultaneously increase the micropores, where soil moisture is held very tightly. In the present study, PAWC calculation was done considering the soil water held between 100-800 kPa for soils of non-sodic nature, and for sodic soils, it was between 300-800 kPa. The revised PAWC data showed a better significant positive correlation with yields of cotton on farmers' field, in comparison to correlation obtained earlier. Thus, it stands as a robust index parameter of soil abiotic stress in SAT environment. This unique parameter having a legacy to major pedogenetic processes in SAT Vertisols: In Indian states under SAT, PAWC emerges as a formidable biophysical parameter for evaluation of rain-fed Vertisols for growing deep-rooted crops.*

***Keywords :*** *Cotton yield; Maharashtra; revised plant available water content (PAWC); SAT Vertisols; soil moisture curves; Vidarbha and Marathwada.*