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Yield Potential of Soil Water and Its Sustainability for Dryland Spring Maize with Plastic Film Mulch on the Loess Plateau

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Plastic film mulch(PM) is an agronomic measure widely used in the dryland spring maize production system on the Loess Plateau of China. The measure can greatly increase yield of dryland maize due to its significant effects on soil water conservation. Few researches have been done to investigate how the yield potential is impacted by PM. The yield-water use (ET) boundary equation raised by French and Schultz provides a simple approach to calculate crop water limited yield potential and gives a benchmark for farmers in managing their crops. However, method used in building the equation is somewhat arbitrary and has no strict principle, which leads to the uncertainty of equation when it is applied. Though using PM can increase crop yield, it increases soil temperature, promotes crop growth and increases the water transpired by crop, which further leads to high water consumption as compared with crops without PM. This means that PM may lead to the overuse of soil water and hence is unsustainable in a long run. This research is mainly focused on the yield potential and sustainability of PMing for spring maize on the Loess Plateau. A principle that may be utilized by any other researchers was proposed based on French & Schultz's boundary equation and on part of quantile regression theory. We used a data set built by collecting the experimental data from published papers and analyzed the water-limited yield potential of spring maize on the Loess Plateau. Moreover, maize yield and soil water dynamics under PM were investigated by a long-term site field experiment. Results show that on the Loess Plateau, the water limited yield potential can be calculated using the boundary equation y = 60.5×(x - 50), with a platform yield of 15954 kg [U+F0D7] hm-2 after the water use exceeds 314 mm. Without PMing, the water limited yield potential can be estimated by the boundary equation y = 47.5×(x – 62.3) , with a platform yield of 12840 kg [U+F0D7] hm-2 when the water use exceeds 325 mm, which means PM can increase the yield potential of spring maize in water limited condition. From the result the field experiment, the grain yield under PM ranged from 6556 to 12615 kg/ha, being 803 to 3616 kg/ [U+F0D7] hm-2 higher than no mulching (CK); and the WUE under plastic mulch ranged from 18.3 to 33.5 kg [U+F0D7] hm-2 [U+F0D7] mm-1, significantly higher than the CK in most of the experiment years (17.5-23.6 kg [U+F0D7] hm-2 [U+F0D7] mm-1). The ET for PM was higher than that of the CK (significance in 2009 and 2011), while it also increased the root biomass in soil, over consumed soil water and improved soil structure increased rainfall infiltration in fallow period. The result shows that the stored water by PM was 12 to 56 mm higher than the CK in the seven experiment years. So after seven years of cultivation, no significant difference was observed between treatments for the soil water storage in 0-6 m soil profile, which means that plastic film mulch can not only increase maize yield, but also is sustainable in the respect of soil water.