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Combining Planting Patterns with Mulching Bolsters the Soil Water Content, Growth, Yield, and Water Use Efficiency of Spring Wheat under Limited Water Supply in Arid Regions

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Abstract: Innovations in water-saving cultivation strategies are urgently needed to achieve high yield and elevated water use efficiency (WUE) simultaneously in arid regions with limited water resources. Here, we conducted a two-year field study to compare the impacts of eight combinations of planting patterns (PPs) and mulching on the soil water content (SWC) in the top 60 cm soil layer, the growth, the yield, and the WUE of wheat under two irrigation rates (1.00 and 0.50 ET). These combinations included three conventional flat planting (CF) patterns, including CF without mulch (CFNM), with plastic film (CFPM), and with wheat straw mulch (CFSM); three raised-bed planting (RB) patterns, including RB without mulch (RBNM), with plastic film (RBPM), and wheat straw (RBSM) mulch; and two ridge–furrow planting (RF) patterns, including RF without mulch (RFNM) and with plastic film mulch (RFPM). The results showed that the tested treatments affected the SWC at different depths under both irrigation rates. Compared with the two non-mulched treatments under 0.50 ET, the SWC of the three PPs with plastic film and the two PPs with wheat straw mulching were significantly higher before irrigation by 14.4–22.0% and 6.9–17.2% at 0–20 cm soil depth, 16.4–29.0% and 6.6–14.9% at 20–40 cm soil depth, and 3.3–34.8% and 3.4–14.5% at 40–60 cm soil depth, respectively. All measured wheat parameters, except harvest index, were significantly affected by the interaction between irrigation rate and PPs. The highest values for plant dry weight (PDW), yield components, grain yield (GY), and WUE under 1.00 ET were obtained in the two PPs with wheat straw mulch, while the three PPs with plastic film showed the highest values of these parameters under 0.50 ET. The yield response factor (Ky) based on PDW was acceptable for all PPs mulched with plastic film and wheat straw as well as for RFNM, while Ky based on GY was acceptable only for the PPs mulched with plastic film and for RFNM, as the Ky values of these PPs were less than 1 under 0.50 ET. The SWC at different depths exhibited quadratic and nonsignificant relationships with all parameters under 1.00 ET, while these relationships were linear and strong under 0.50 ET, with a few exceptions. Overall, we conclude that combining any PPs with plastic film mulching could be used as a feasible and effective strategy for obtaining high wheat yield and WUE in the irrigated and arid agroecosystem.

Keywords: plastic film mulching; production functions; ridge–furrow; wheat straw mulching; water-saving; yield response factor

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