Abstract

In the typical rainfed agricultural regions of China such as the Loess Plateau, average annual rainfall ranges from 300 to 550 mm. Spatial and temporal distribution of rainfall is extremely uneven and there is a serious dislocation between water supply and demand during critical period of crop water requirement. Developing efficient rain-harvesting farming technology is critical for local food production. Over last three decades, micro-field rain-harvesting and evaporation-preventing techniques have gradually become major tillage management approaches in rainfed agricultural areas of the Loess Plateau. Since 1980s, various micro-field rainwater-harvesting techniques have been developed with integrating mulching (film, gravel or straw) practices in the Loess Plateau. These techniques include ridge-furrow cultivation with half, whole or without mulching, and flat planting with mulching. Especially, large-area extension and application of the techniques for ridge and furrow with whole plastic mulching has played a vital supporting role to ensure the increase in grain yield per unit area in a large extent in dry areas of northwest China. Currently, this farming technique was widely recognized as an optimal pattern of micro-field rain-harvesting technology. In general, micro-field rainwater-harvesting mulching technology was designed as alternating furrow and ridge array with partly or fully mulching on the topsoil. The ridge and the furrow were used to harvest and collect runoff, respectively, and crop was planted in the furrow. This paper reviewed the evolution process of micro-field rain-harvesting and evaporation techniques and their influences on farmland ecosystem. We also summarized the effects of ridge-furrow mulching modes and sowing methods on crop yield formation, water use efficiency, crop ecophysiology, soil quality, soil microbial, weeds, plant diseases and insect pests, mulching residues and crop phenology. In addition, enhanced productivity and efficiency, potential ecological risks of these techniques and their interactions were analyzed. As for design of ridge and furrow specification, the width ratio between ridge and furrow varied from crop type, rainfall amount to air temperature. In most areas of the Loess Plateau, the optimal width ratios between ridge and furrow were 60 cm: 40 cm and 60 cm: 60 cm for potato and corn, respectively, to achieve the greatest grain yield. Among a variety of mulching materials, plastic film was the most widely used, mainly because it displayed the advantages in evaporation prevention, yield improvement and low price. Existing studies showed that plastic mulching would increase soil surface temperature and lead to better performance in grain yield and dry matter accumulation particularly in those areas with high elevation and low accumulated temperature. In the areas with annual air temperature accumulation of less than 5°C, grain yield of plastic-mulched corn was up to 11 times more in comparison with that of traditional flat planting system. In addition, this technique increased the residues of root system in soil, and accordingly enhanced population sizes and biological activities of soil bacteria and fungi. Furthermore, crop growth period was shortened by 7-15 days as a result of application of this technology in the Loess Plateau. However, plastic film mulching for years brought about increased plastic residues in soil and accordingly led to soil pollution and related environmental problem. Finally, efficiency, sustainability and developmental potential of these techniques were discussed aiming to provide theoretical guidance for sustainable management of rainfed agricultural ecosystem.