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Buried straw layer plus plastic mulching reduces soil salinity and increases sunflower yield in saline soils

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ABSTRACT

Soil salinization is a major limitation to high crop yield in saline soils of the Hetao Irrigation District of Inner Mongolia, China. As such, people are forced to use better and more effective approaches to soil management due to scarcity of freshwater and the adverse effects of climate. A three-year field experiment was conducted to investigate the effects of buried straw layer and plastic film mulch on soil moisture, soil salinity and sunflower (*Helianthus annuus* L.) yield in saline soils. Four field management practices were designed: bare ground (BG), plastic mulch (PM), buried maize straw layer (12 t ha^{-1}) at a depth of 40 cm (SL), and combined application of plastic mulch and straw layer burial (PM + SL). Soil water at the 0–40 cm layer was higher under SL and PM + SL than under BG and PM within 45 days after sowing (DAS) but the reverse occurred thereafter. Compared to PM and BG, both SL and PM + SL significantly decreased the salt content of the upper 40 cm depth at sowing. Furthermore, PM + SL invariably decreased the salt content throughout the growth period of sunflower. In contrast, SL and PM moderately increased the salt content during the later growth period. Compared with BG, SL significantly decreased salt accumulation in the off season. Over the three years, the highest seed and biomass yield, 100-seed weight and head diameters of sunflower were obtained from the PM + SL plots. The average seed yield (3198 kg ha^{-1}) under PM + SL exceeded the yields under BG, PM and SL by 51.9, 5.9 and 35.7% respectively. Therefore, PM + SL may be an efficient practice for reducing soil salinity and increasing sunflower yield in the Hetao Irrigation District and other similar ecological areas.

1. Introduction

Soil salinization is one of the major causes of declining agricultural productivity in numerous arid and semiarid regions throughout the world (Qadir et al., 2000). High salinity has been a significant threat to the sustainable development of agriculture (Mondal et al., 2001; Bakker et al., 2010). The Hetao Irrigation District, located in northwest China, has an irrigated land area of 570,000 ha. Approximately half of the irrigated land in this area has saline-alkali problem. High evaporation rate, limited rainfall and shallow groundwater table contribute to the increase in soil salinity (Lei et al., 2011). It was reported that most of the saline soils in the area will eventually become totally unproductive and possibly abandoned if the salinity problem could not be resolved immediately and effectively (Wu et al., 2008).

As a salt-tolerant crop, sunflower is one of the most important crops in this region. Nevertheless, its germination, emergence, and early growth are very sensitive to soil salinity (Katerji et al., 1994, 1996). Salt accumulation in the root zone is the main cause of yield decline. Irrigation with water from the Yellow River is the most readily available strategy for reducing salinity in saline fields (Feng et al., 2005). However, excessive irrigation without appropriate drainage systems raises the groundwater table. Thus, this management option can potentially cause salt accumulation in the root zone, with a negative effect on crop productivity (Sharma and Minhas, 2005; Qadir et al., 2009). In recent years, the amount of water for irrigation coming from the Yellow River has reduced significantly, thus creating a conflict between water shortage and salinity control in this region (Lei et al., 2011). Therefore, new techniques should be developed to address these challenges.

Soil and water management approaches should aim to reduce unproductive water losses associated with evaporation from soil surfaces, increase soil moisture storage, maintain soil salinity levels within acceptable crop production limits, enhance soil organic matter inputs and nutrient availability, and maintain soil physical properties in the root zone (Bezborodov et al., 2010).

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