Published December 20, 2018

Subsurface Organic Amendment Plus Plastic Mulching Promotes Salt Leaching and Yield of Sunflower

Hongyuan Zhang, Huancheng Pang, Chuang Lu, Xu Zhang, and Yuyi Li*

ABSTRACT

In order to evaluate the effects of subsurface organic amendment plus plastic mulching on soil salinity, soil pH, available nutrients and crop growth on saline–alkali soils, four management practices were conducted in 2015–2016, including plowing without plastic mulching (CK), plowing plus plastic mulching (PM), subsurface (10–30 cm) treatment with organic manure (OM), and OM plus plastic mulching (PM + OM). The result showed that OM and PM + OM enhanced the salt leaching after irrigation and regulated salt distribution to facilitate crop growth. Compare with CK, OM , and PM + OM reduced pH of 10to 30 cm by 0.36 to 0.6 in 2015 and 0.30 to 0.45 in 2016 ($P < 0.05$), respectively. Relative to that of CK, soil organic matter, available N, P, and K of 0 to 40 cm under OM and PM + OM increased by 53.77 to 73.11%, 63.65 to 69.51%, 406.06 to 381.31%, 266.42 to 229.80% in 2015, and by 45.06 to 68.38%, 52.25 to 49.34%, 603.23 to 612.75%, 166.32 to 132.88% in 2016 ($P < 0.05$). Compared with CK and PM, PM + OM increased sunflower yield by 45.08 and 19.37% in 2015, by 24.29 and 6.62% in 2016 ($P < 0.05$), mainly due to a reduction of pH, the increase of soil organic matter and available nutrient, high water after irrigation as well as regulation of the water and salt. Therefore, amending the subsurface layer with organic manure combined with plastic mulching is a viable option for improving sunflower production in the saline–alkali soil of Hetao Irrigation District of Inner Mongolia or other areas with similar soil conditions.

Core Ideas

- Salt reduction effect of organic amendment with mulch intensified with years.
- Organic amendment gradually reduced soil pH within the 10- to 40-cm layer.
- Organic amendment increased the soil organic matter and available nutrients.
- The sunflower yield was highest under the organic amendment with plastic mulching.

Published in Agron. J. 111:457–466 (2019)
doi:10.2134/agronj2018.02.0097

Soil salinization is estimated to affect more than one-fourth of the world's cultivated systems, and is especially prevalent in the arid and semiarid lands (Qadir et al., 2000). The Hetao Irrigation District located in the dry region of Northwest China, has large and widely distributed saline soils due to its special geographical environment and climatic conditions. In this area, irrigation is essential for agricultural production. However, insufficient drainage and over irrigation have aggravated the problem of soil salinization (Saysel and Barlas, 2001). At present, the salinization of cultivated land has spread to an area of 345,300 ha, accounting for 45.12% of the total cultivated land. Salinization has become the major problem affecting the local agricultural production, ecological environment, and socio–economic development (Li et al., 2010). In the development and utilization of saline–alkali arable land resources, it is possible to create a suitable soil environment for cropping through scientific and rational soil tillage based on optimum irrigation and drainage (Gwenzi et al., 2008).

The application of organic manure and mulching has been considered as an effective way for improving the saline soils (Bhatti et al., 2005). Generally, the organic manure can improve the structure and properties of soil, promote the formation, and stabilize the aggregates and porosity (Mikha and Rice, 2004), and lessen compaction (Mosaddeghi et al., 2009). It can also enhance the hydrodynamic regimes (Celik et al., 2004; Fares et al., 2008; Johnson et al., 2006), and increase the contents of SOM, nutrients (Aggelides and Londra, 2000; Egashira et al., 2003), and salt-leaching capacity of the soil (Tzanakakis et al., 2011). However, the application of organic manure may also produce some risk of secondary salinization because it contains large amounts of salt ions (Li-Xian et al., 2007). On the other hand, surface mulching was widely applied in dry saline soils, which regulates soil water, restrains soil evaporation and salt accumulation (Ramakrishna et al., 2006). It may establish the patterns of nutrient cycling that is more similar to the natural ecosystems, as well as promote crop growth (Bezborodov et al., 2010; Mulumba and Lal, 2008). Also, plastic film mulches was found to increase the total porosity and decreased bulk density (Mbah et al., 2010).

Although the benefits of organic manure and mulch have been observed in most soils, most studies about organic manure

H. Zhang, H. Pang, C. Lu, and Y. Li, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing, China, 100081; X. Zhang, Liaoning Institute of Agricultural Mechanization, Shenyang, China, 110161. Received 9 Feb. 2018. Accepted 25 Sept. 2018. *Corresponding author (liyuyi@caas.cn).

Abbreviations: CK, plowing without plastic mulching; OM, organic manure amendment of the subsurface (10–30 cm); PM, plowing plus plastic mulching; PM + OM, OM plus plastic mulching.