Soil Salinity and Sodicity under Long-Term Irrigated Organic Farming in New Mexico

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Introduction

- With a renewed interest and demand in organic products, organic agriculture has become one of the fastest growing industries in the US including New Mexico.
- Organic farmers rely on non-chemical methods to build soil fertility including crop rotations, green manures, and animal manures.
- One concern with continued and excessive use of animal manures over the years in arid irrigated agriculture in New Mexico is potential buildup of soil salinity.
- Irrigation can leach the salts down from the soil surface and may lead to accumulation of salts in deeper soil depths.

Objectives

- To investigate soil salinity and sodicity of furrow or flood irrigated agricultural fields at different soil depths under different years of certified organic farming as compared with a conventional farm in southern NM.

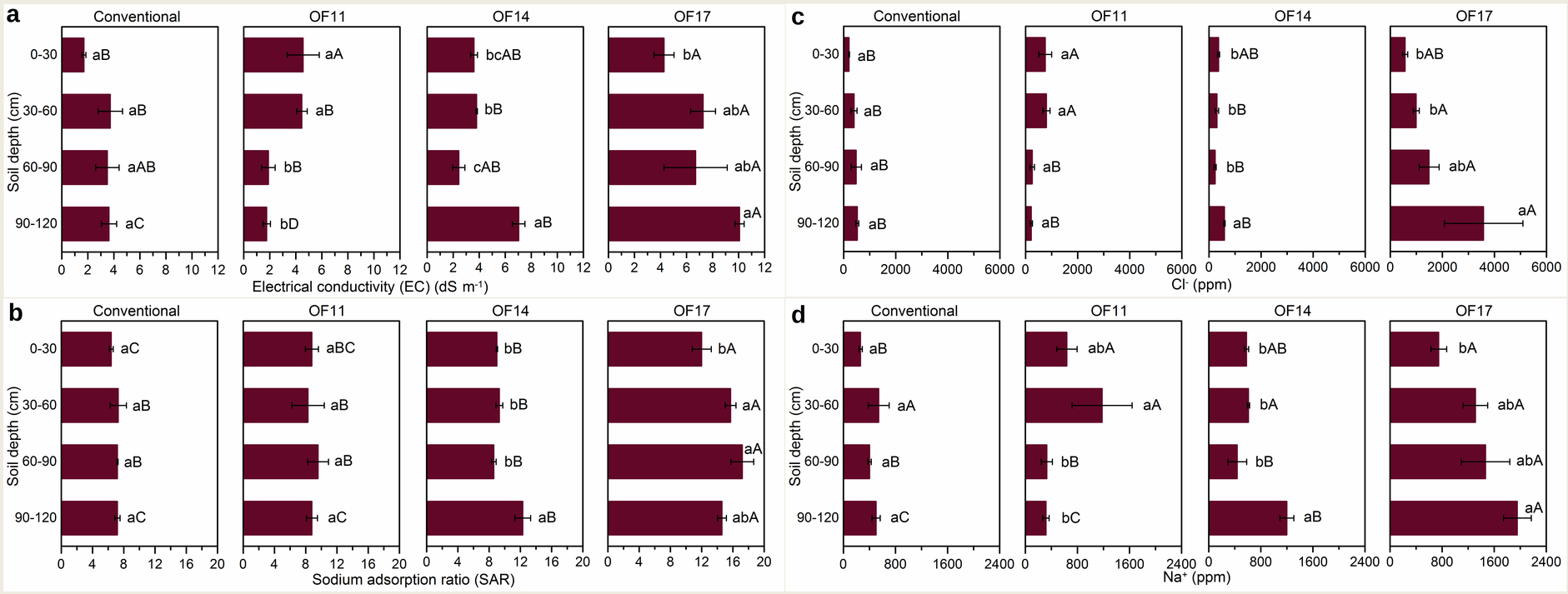
Methods

- Four farms selected in southern New Mexico: (i) a conventional farm as a control (32° 03′ 13″ N, 106° 38′ 29″ W 32°), and (ii) three farms under certified organic for last 11 years (OF11), 14 years (OF14) and 17 years (OF17) (32° 01′ 58″ N, 106° 38′ 15″ W).
  - Soil: Harkey (coarse-silty, mixed, calcareous, thermic typic Torrifluvents), deep, well drained
  - Climate: Arid with mean annual temperatures ranging from 19-20ºC and mean annual precipitation from 180-230 mm.
  - Tillage: Conventional with moldboard plowing followed by 35 cm deep chisel tillage.
  - Irrigation: Flood (alfalfa) or furrow (other crops).
- Soil samples collected at 0-30, 30-60, 60-90 and 90-120 cm (Fig. 1) in spring, 2013.
- Saturated paste extracts used for soil EC, SAR, Cl^- and Na^+ measurements (Fig. 2).
- Fisher's LSD (0.05) obtained using a one-way analysis of means to compare for depths within each farm and different farms at each depth.

Fig. 1. Soil sampling

Fig. 2. Soil saturation paste extraction

Results



Figures 3a-d. Soil electric conductivity (EC), sodium adsorption ratio (SAR), Cl^- and Na^+ of the saturation extract, for the soil depths of 0-30, 30-60, 60-90 and 90-120 cm at a long-term conventional and three organic farm sites. Organic farms OF11, OF14 and OF17 were under certified organic for the last 11, 14 and 17 years, respectively. Error bars are standard errors. The lower case letters are used to compare different depths within each farm, while capital letters are to compare different farms at each depth. Means followed by the same lower case and capital letters are not significantly different with Fisher's LSD ($P \leq 0.05$).

Table 1. Cropping history and average annual animal manure applications received in the conventional and three organic farms in New Mexico.

Farm	Cropping history	Average annual animal manure received	
		Dried cow manure† Mg ha^{-1} yr^{-1}	Dry chicken pallets‡ Mg ha^{-1} yr^{-1}
Conventional	Pima Cotton: 2001-06; Upland Cotton: 2007-09; Corn: 2010-11 Cotton:2012	-§	-
OF 11	Alfalfa: 2001-03; Pima Cotton: 2004-06; Alfalfa: 2007-2010; Pima Cotton: 2011-12	8.2	0.35
OF 14	Cotton: 1999; Corn: 2000; Alfalfa: 2001-03; Oats: 2004; Lettuce: 2005; Chile: 2006; Upland Cotton: 2007; Alfalfa: 2009-12	7.1	0.28
OF17	Cotton/Pima Cotton: 1996-1997; Corn: 1998; Alfalfa: 1999-2002; Fallow: 2003-04; Lettuce: 2005; Cotton/Pima Cotton: 2006-07, 2009-11; Chile: 2008; Alfalfa: 2012	17.1	0.18

Organic farms OF11, OF14 and OF17 were under certified organic for the last 11, 14 and 17 years, respectively.
† dried cow manure N-P-K, 1.1-0.4-0.8%; applied only to annual crops, mainly during cotton years @ 50 Mg ha^{-1}
‡dry chicken pallets N-P-K, 4.0-2.6-2.5%; applied mainly during alfalfa years @ 0.18 Mg ha^{-1} twice in growing season.
§Conventional farm received no cow manure or chicken pallets, but received 113.4 L/ha liquid fertilizer URAN (10-34-0; N-P-K) at pre-plant and two more applications of URAN (32-0-0; N-P-K).

- Soil EC and SAR changed significantly with increasing soil depths for all the farms. Generally all the organic farms had higher EC and SAR than the conventional farm, with the differences being significantly higher under the oldest organic farm OF17 (Fig. 3a-b).
- Similar trends were observed for Cl and Na with increasing levels at lower depths (Fig. 3c-d). The increased EC and SAR with increasing soil depth at the OF14 and OF17 could be due to corresponding increasing concentrations in Cl^- and Na^+ within the 0-120 soil profile (Fig. 3c-d).

Conclusion

- Soil salinity and sodicity levels were generally higher under organic farms than the conventional farm.
- Soil salinity and sodicity levels within 0-60 cm (generally root zone depth) were lower; however, increased soil EC within the deeper 90-120 cm was observed as the number of years under certified organic practices increased.
- Organic farms need to be monitored for salt levels and have a management plan to prevent excessive build-up of salts.

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