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Evaluations of impacts of different management systems on soil quality in California's Central Valley (preliminary results) *

Introduction

Many agricultural production systems that have been developed during the last half of the 20th century in California's Central Valley are highly specialized and relatively intensive in terms of variety of inputs. In recent years, producers and researches have been investigating a variety of management alternatives that sustain productivity while at the same time conserve or improve the soil and water resource bases throughout the region.

In 1995 the West Side On-Farm Demonstration Project was started by farmers, University of California researchers, private consultants and Natural Resource Conservation Service conservationists to evaluate impacts of routine organic amendment inputs including compost, manure and cover crops, on soil chemical, physical and biological properties. The project consisted of 12 side-by-side, on-farm comparisons of alternative (organic amendment applications) and conventional (unamended) production systems in the West Side Region between Huron and Mendota. This paper presents soil property data summaries for five participating farms at which relatively consistent use of amendments was made in the alternative system during the course of the project.

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Materials and methods

On-farm soil sampling was conducted in Western Fresno County from fall 1995 through fall 1998. Samples were collected each spring and fall during the project. Twelve farms, collectively representing about 36,000 ha, participated to the project with over 650 ha allocated to the project (fig. 1). At the start of the project, adjacent, homogeneous fields were randomly designated alternative and conventional at each site. Cover crops, compost or manure were used as amendments in the alternative management system (tab. 1). Compost or manure applications ranged from 5.6 to 9 t ha^{-1} at each alternative field. In 1997, adjacent long-term organic, conventional and a conventional fields that was being transitioned in organic production, were added to the main comparison of compost and manure at fields.

The sampling scheme was fixed at the beginning of the project. Six soil samples, each of eight to twelve sub samples, were taken from the surface 15 cm of soil in alternative and conventional fields at each farm in spring and fall of each year. Each composite sample was collected from an area of about 706 m^2. After collection, the soil samples were refrigerated, passed through 1.27x1.27 cm, homogenized and taken to University of California's Division of Agriculture and Natural Resource Analytical Laboratory for the following chemical analyses using standard protocols: pH, electrical conductivity (EC), cation exchange capacity (CEC), SAR, Na, soil organic matter (SOM), total Kjeldahl nitrogen (TKN), exchangeable K (X-K), Zn, Mn, P-Olsen, and Ca. Soil aggregate stability was measured using a modification of the water stable aggregate method of Kemper and Rosenau (1986). Microbial biomass carbon and nitrogen were determined using the protocol of Horwath and Paul (1994).

Table 1. *Treatment and crop from the year 1996 through 1998 in 5 farms.*

Year 0 BIFS Project		Crop	Year 1st BIFS Project Treatment	Crop	Year 2nd BIFS Project Treatment	Crop
Farm	Treatment					
1	Compost/Chicken manure	Tomato	Cover crop/Sudan grass	Cotton	Compost	Cotton
2	Compost/Cow manure	Tomato	Compost/Cow manure	Garlic	Compost man/Man	Cotton
3	Compost/Gin trash	Tomato	Sudan grass/Gin trash	Onions	Gin trash/Dairy manure	Cotton
4	Compost	Tomato	Sudan grass/Cow man-yard waste	Tomato	Sudan grass	Cotton
5	Compost	Tomato	Poultry Manure/Compost	Melons	Manure/Compost	Tomato

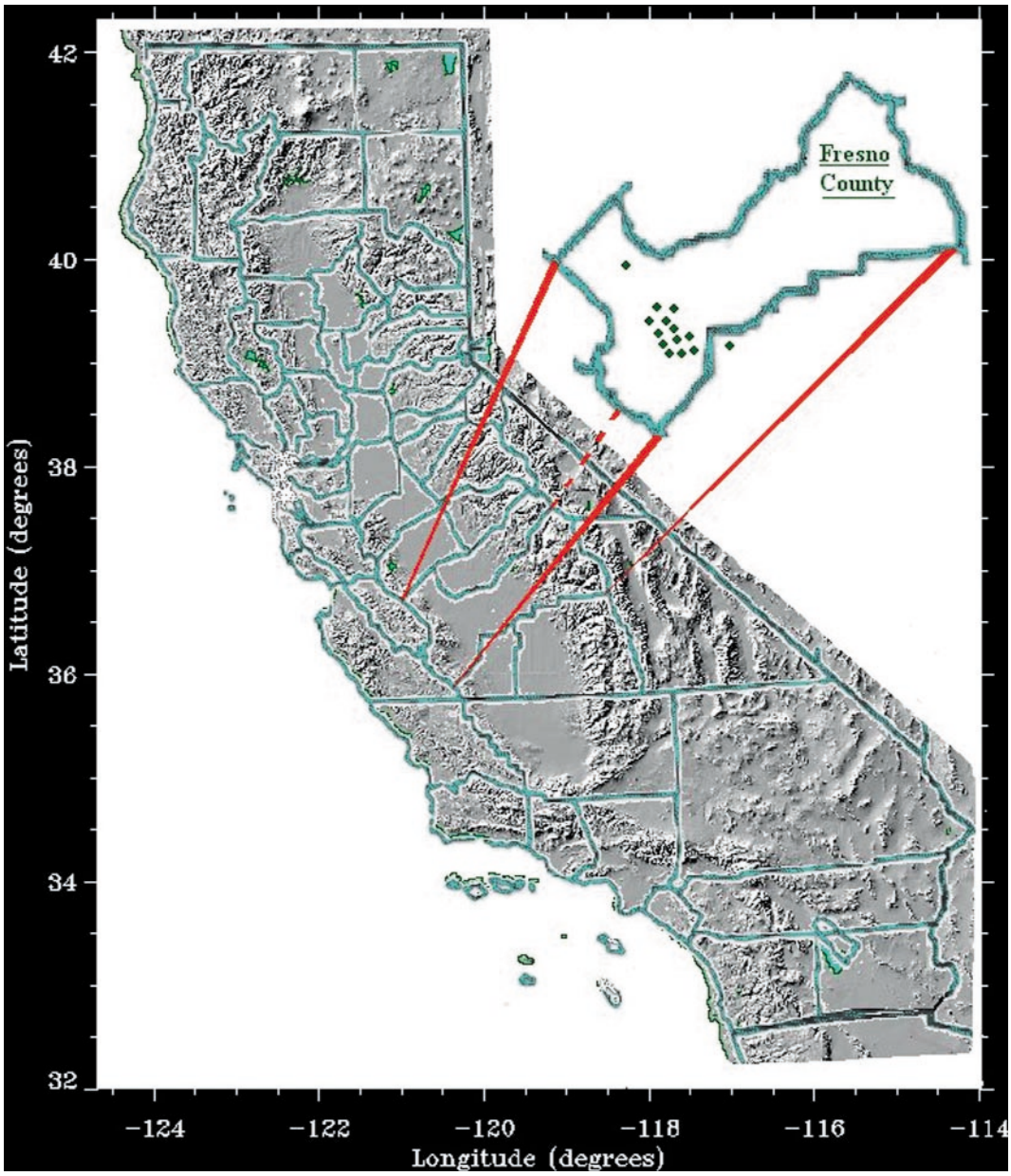

Fig. 1. BIFS Project Area and farm localization.

Data collected at all farms were analyzed for each management system using a t-test procedure (SAS Institute, 1993). In 1998, the expanded data set collected from farm 5 that included five management systems (organic, compost, manure, transitional and conventional) was compared by one-way analysis of variance (ANOVA) using SAS (SAS Institute, 1993) followed by LSD test where $P \leq 0.05$.

Results and Discussion

Figure 2 shows data for pH measured at four sites during the project's period. In general, the alternative management system did not influence soil pH. The use of manure or cover crops in the alternative cultural system also did not change soil salinity (EC) in any consistent way. In fact, electrical conductivity was significantly modified during the project period in farm 3 only (fig. 3).

The alternative cultural system did, however, impact total Kjeldahl nitrate, organic matter and exchangeable K in the soil. During the study period, N, SOM and K were generally higher in the alternative system beginning in the second year of the study. (Fig. 4, 5, 6). The highest difference in TKN, between the alternative and conventional systems was seen at farm 4 (0.069% and 0.038% respectively in alternative and conventional) in the last year of the project. The largest difference in exchangeable K was seen in farm 2 during fall 1997 with a difference of 218.30 g K kg^{-1}. Similar observations have been reported in low-input and organic farming system treatments by Clark *et al.* (1998) in research conducted in California's Sacramento Valley.

Higher soil organic matter content was measured in the alternative system in all farms (Fig. 6). The biggest difference in soil organic matter is seen in farm 3 with value of 1.06 in the alternative system and 0.70 in the conventional. Generally, soil organic matter was increased in the alternative system with respect to the conventional through the project. In farms 1, 2, and 3 soil organic matter content seemed to increase more than at farm 4. This finding may depend on the type of organic input used (cover crops at farm 4 versus compost at the other farms).

Data for other soil properties that were determined are presented in a paper by Andrews *et al.*, (submitted).

Data measured at farm 5 in the last year of the project for five different cultural systems (organic, alternative (compost and manure), transitional and conventional) are presented in figure 7. Soil pH was the only property that didn't change between cultural systems. Other soil properties analyzed (EC, CEC, SOM, WSA, MBC, MBN, TKN, X-K, Zn, Mn, Fe, P-Olsen, and PMN) revealed significant differences between the systems. The organic system showed significantly higher values and the conventional and transitional resulted in the lowest values.

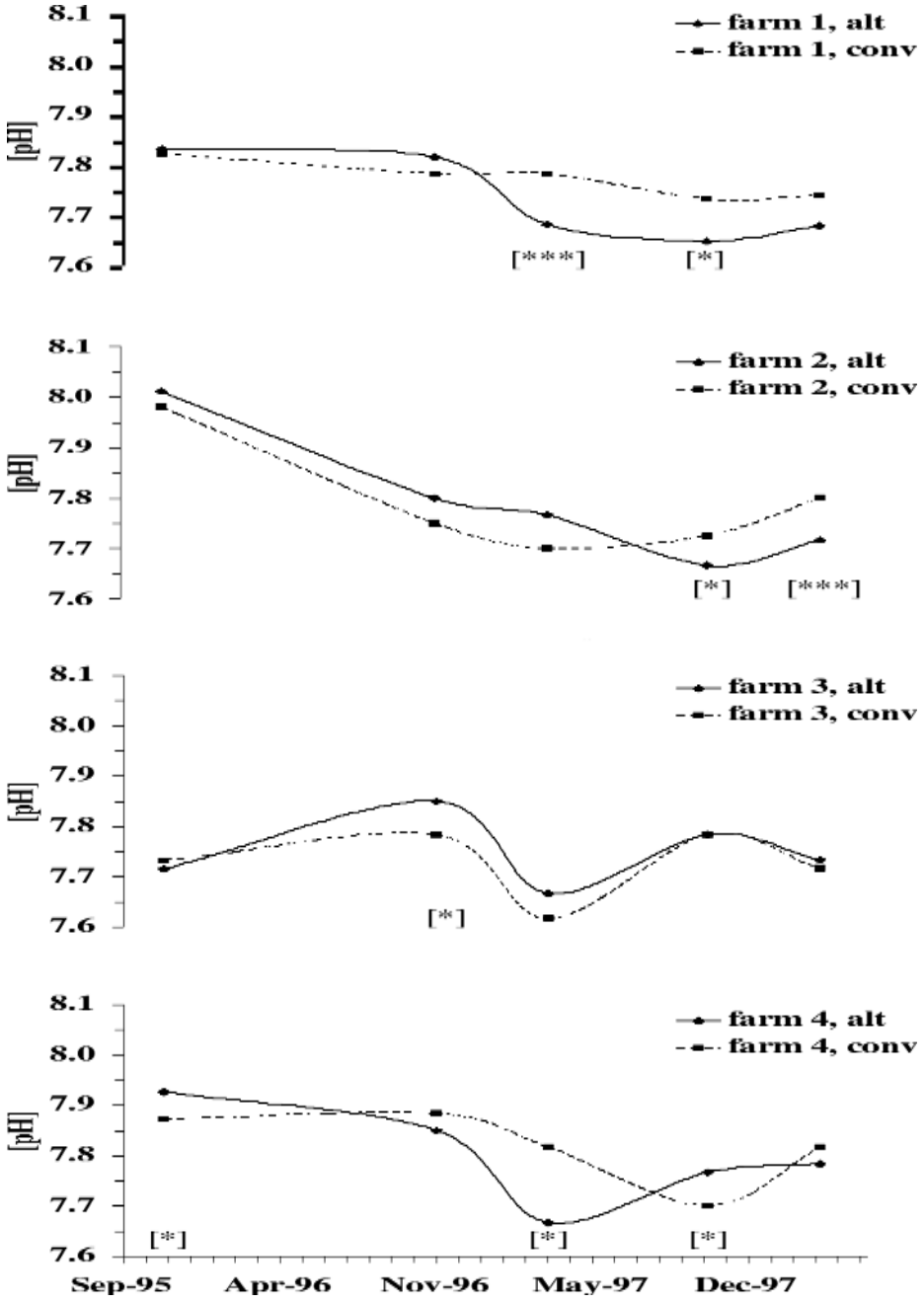

Fig. 2. Soil pH in alternative and conventional cultural systems from fall 1995 to spring 1998 at four farms in California's San Joaquin Valley.

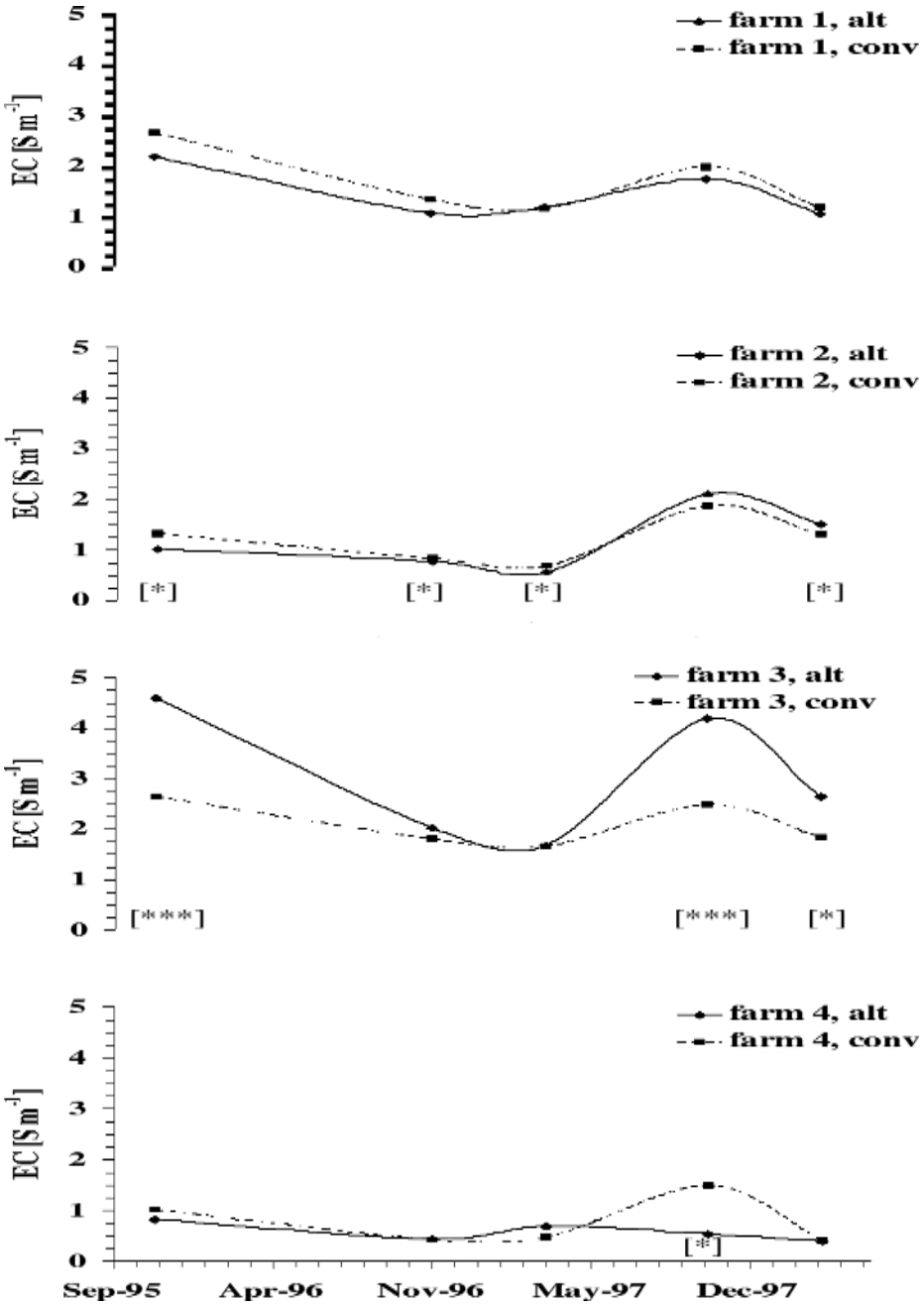

Fig. 3. Soil electrical conductivity (EC) in alternative and conventional cultural systems from fall 1995 to spring 1998 at four farms in California's San Joaquin Valley.

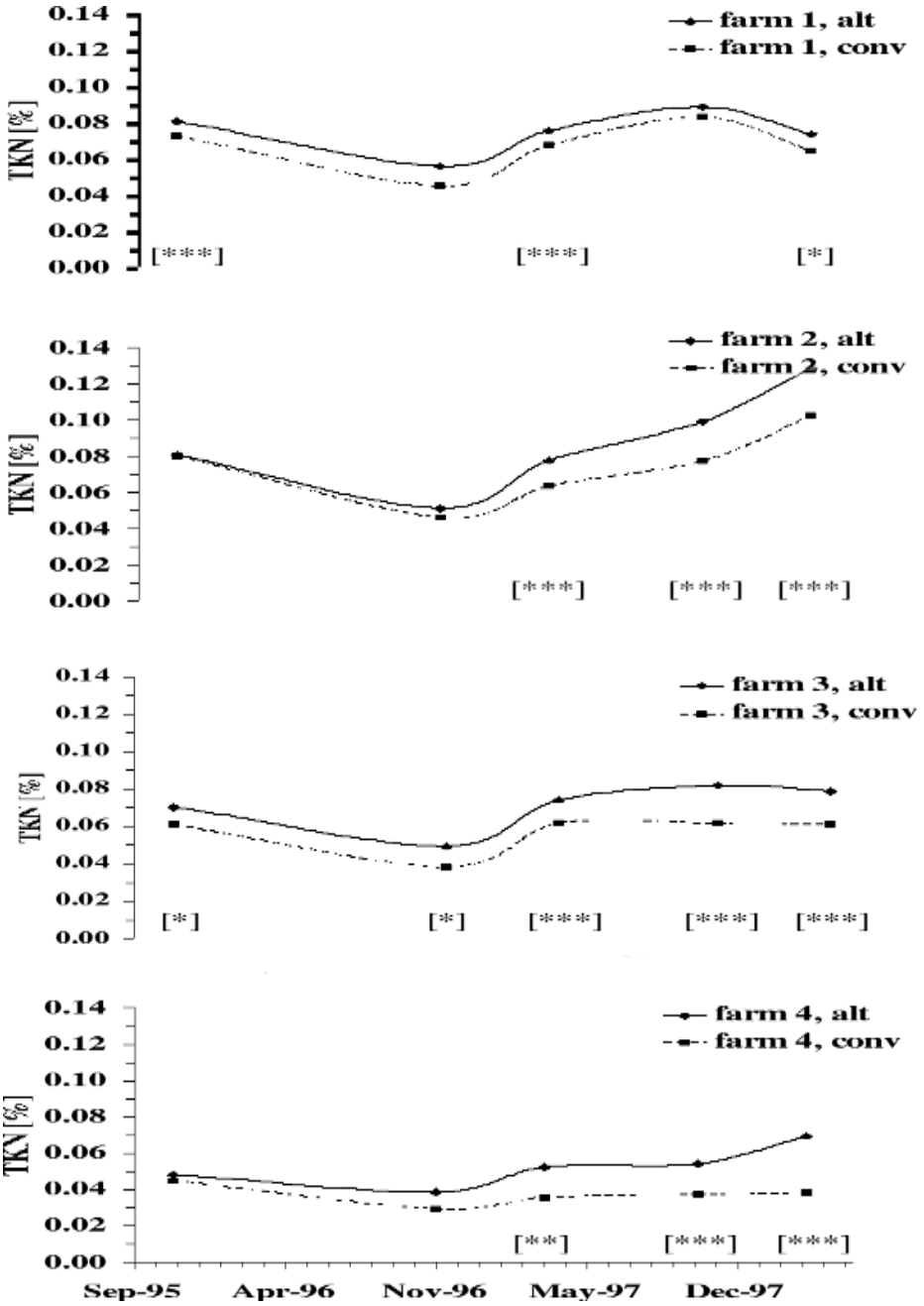

Fig. 4. Soil Total Kjedahl nitrogen (TKN) in alternative and conventional cultural systems from all 1995 to spring 1998 at four farms in California's San Joaquin Valley.

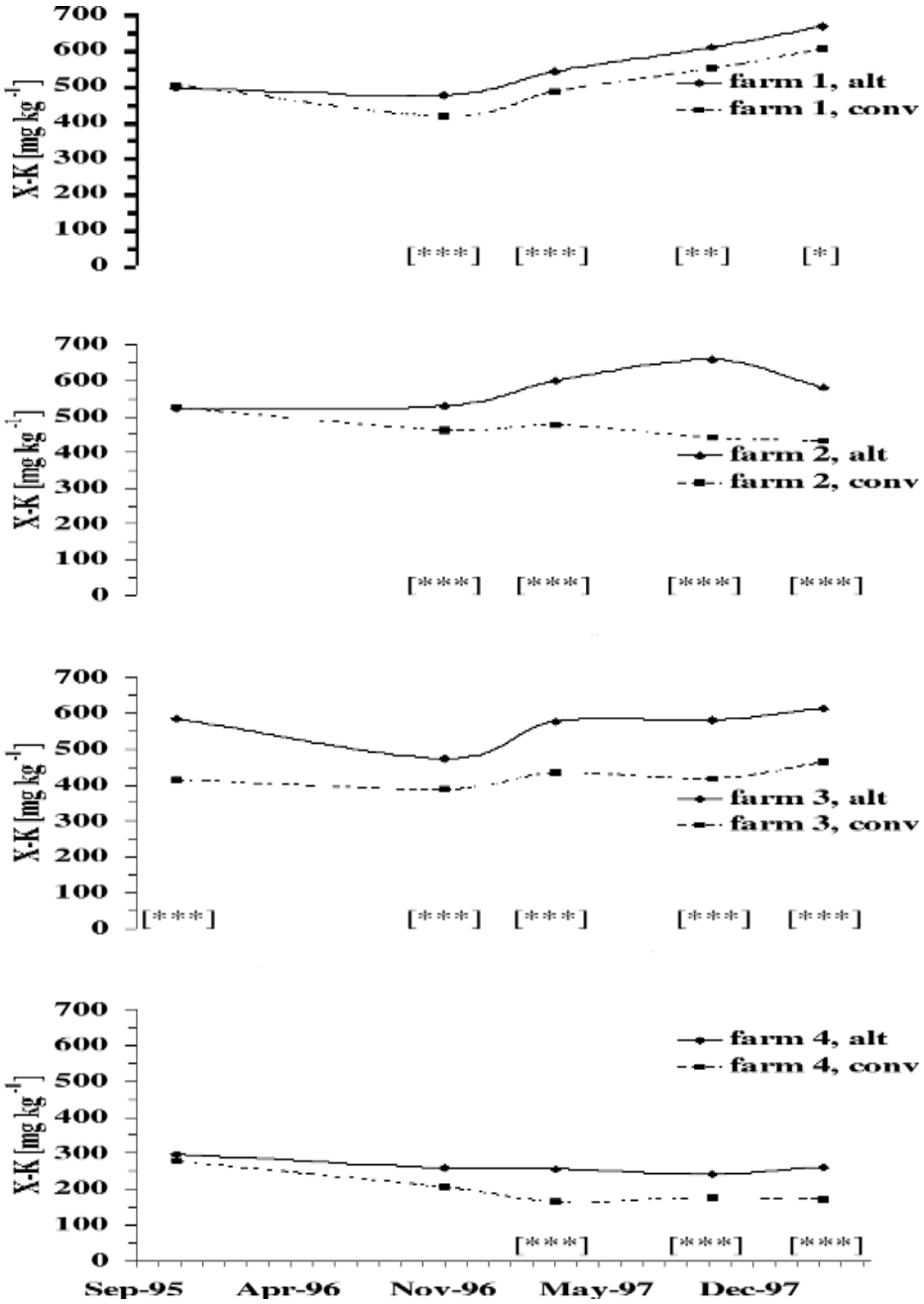

Fig. 5. Soil exchangeable K (X-K) in alternative and conventional cultural systems from fall 1995 to spring 1998 at four farms in California's San Joaquin Valley.

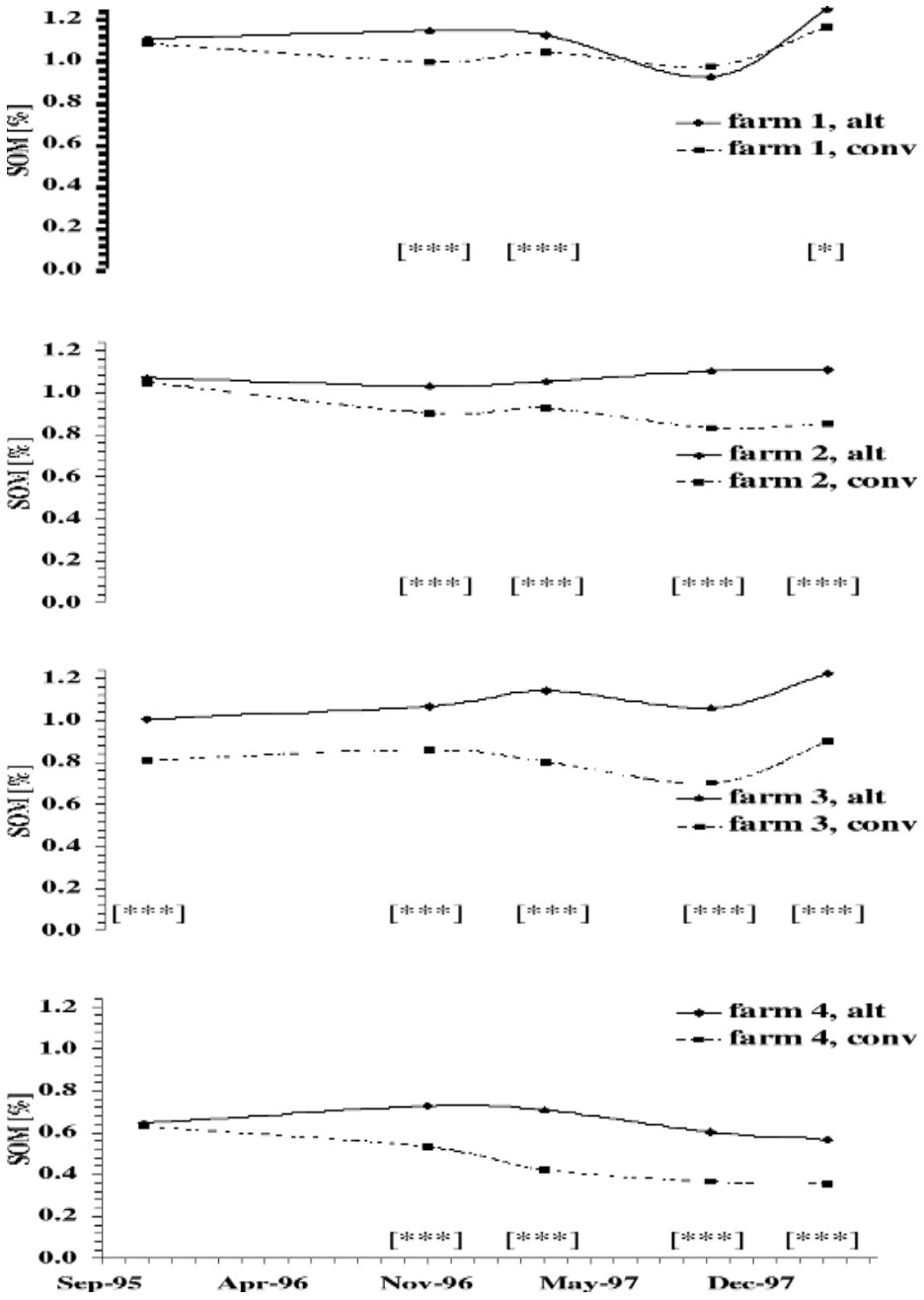

Fig. 6. Soil organic matter (SOM) in alternative and conventional cultural systems from fall 1995 to spring 1998 at four farms in California's San Joaquin Valley.

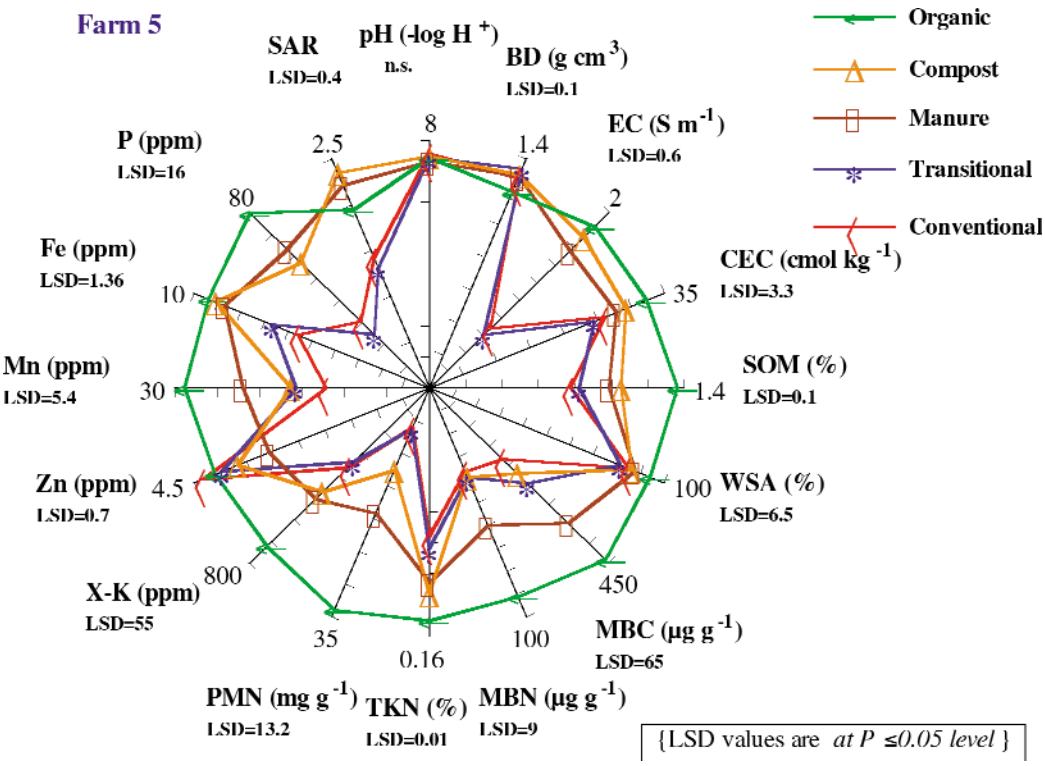

Fig. 7. Cultural system effect in 1998 Spring on pH, Bulk Density (BD), electrical conductivity (EC), cation exchange capacity (CEC), soil organic matter (SOM), water stable aggregates (WSA), microbial biomass C (MBC), microbial biomass N (MBN), total Kjeldahl nitrogen (TKN), potentially mineralizable nitrogen (PMN), exchangeable K (X-K), Zn, Mn, Fe, P-Olsen (P), SAR in the farm 5.

Preliminary finding summarized

Results obtained from on-farm soil property monitoring within the West Side On-Farm Demonstration Project have given very interesting preliminary information about prospects for improving soil quality and therefore environmental quality.

These preliminary results indicate that changes in several soil properties result from organic amendment applications in this region. The functional importance and economic implications of these preliminary finding require further study.

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