IMPACT OF BIOSOLID-COMPOST, MANURE AND MINERAL FERTILIZER ON ALFALFA YIELD AND SOIL FERTILITY

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INTRODUCTION

With the world's population projected to steadily increase for the next few decades, metropolitan areas like the Los Angeles Basin and the Inland Empire (Riverside and San Bernardino Counties, Fig. 1A) will continue expanding their population and the amount of waste produced.

Nearby agricultural fields such as in the High Desert (Fig. 1B) could be a feasible and sustainable destination for waste-derived materials such as biosolid-compost, however, not without possible disadvantages and risks. Elevated levels of salts, micronutrients and heavy metals are usually a concern with the use of these materials. Biosolid-compost has been used as a supplemental phosphorus alternative to mineral fertilizers.

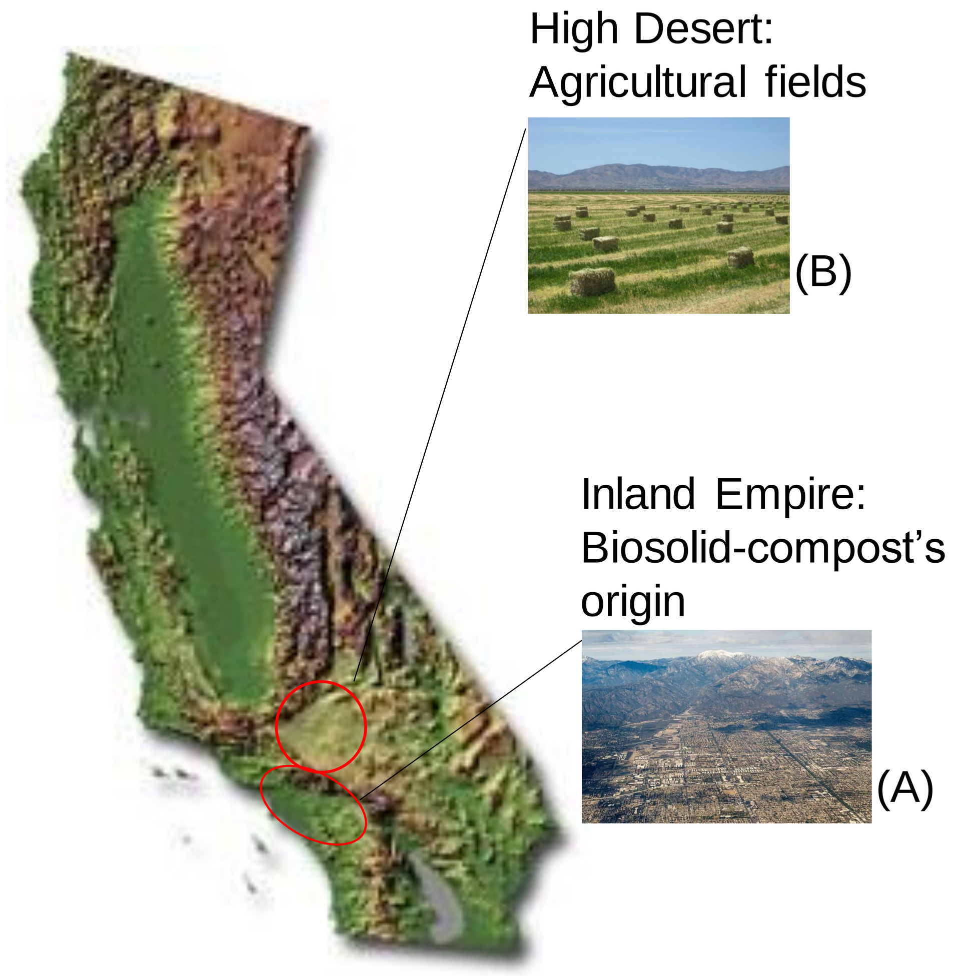

Figure 1. California map.

OBJECTIVE

Asses the impact of different rates of biosolid-compost, dairy manure and mineral fertilizers on alfalfa yield and soil fertility.

MATERIAL AND METHODS

- Class A Biosolid-compost, produced by the Inland Empire Regional Composting Authority, Rancho Cucamonga, CA:
  ~35% biosolids
  ~65% stable bedding + green waste)
- Field Location: Newberry Springs,CA (Fig.1B)
- Soil series: Cajon Mixed, thermic Typic Torripsamments; sandy, very deep, somewhat excessively drained soils that formed in sandy alluvium from dominantly granitic rocks

- Experimental design: Randomized complete block, with 4 replications; Plot size: 3.05 by 6.1m
- The treatments (Table 1) were broadcast by hand on a 1-year old alfalfa (*Medicago sativa* L.) field on February 4th, 2013

Table 1. Treatment number, material source, application rate and equivalent amounts of potassium and phosphorus.

Treatment			Equivalent in kg ha^{-1} of:	
#	Source	Application rate (Mg ha^{-1})	K_2O	P_2O_5
1	Biosolid-compost	11.2	59	302
2	Biosolid-compost	22.5	119	605
3	Biosolid-compost	33.7	178	907
4	Dairy manure	22.5	59	84
5	Dairy manure	45.0	119	168
6	Potassium chloride (0-0-60)	0.20	59	0
7	Potassium chloride (0-0-60)	0.40	119	0
8	*MAP (11-52-0)	0.31	0	84
9	MAP (11-52-0)	0.62	0	168
10	(0-0-60) + (11-55-0)	0.20 + 0.62	59	168
11	(0-0-60) + (11-55-0)	0.40 + 0.62	119	168
12	Control (none)	-	-	-

*MAP: Monoammonium phosphate

- Prior to the implementation of the treatments, composite soil samples of the study site were analyzed for chemical and physical properties
- Alfalfa yields were measured during the first 5 cuttings (out of 6) by harvesting the center 1.5 by 4.6m of each plot
- Soil samples from 0-15cm were collected from each plot in June 2013
- Plant tissue and soil samples of treatments 3 and 12 were collected at the 5th cutting and analyzed for heavy metals: Zn, Cu, Cd, Cr, Pb, Mo, Ni, Se and As

RESULTS AND DISCUSSION

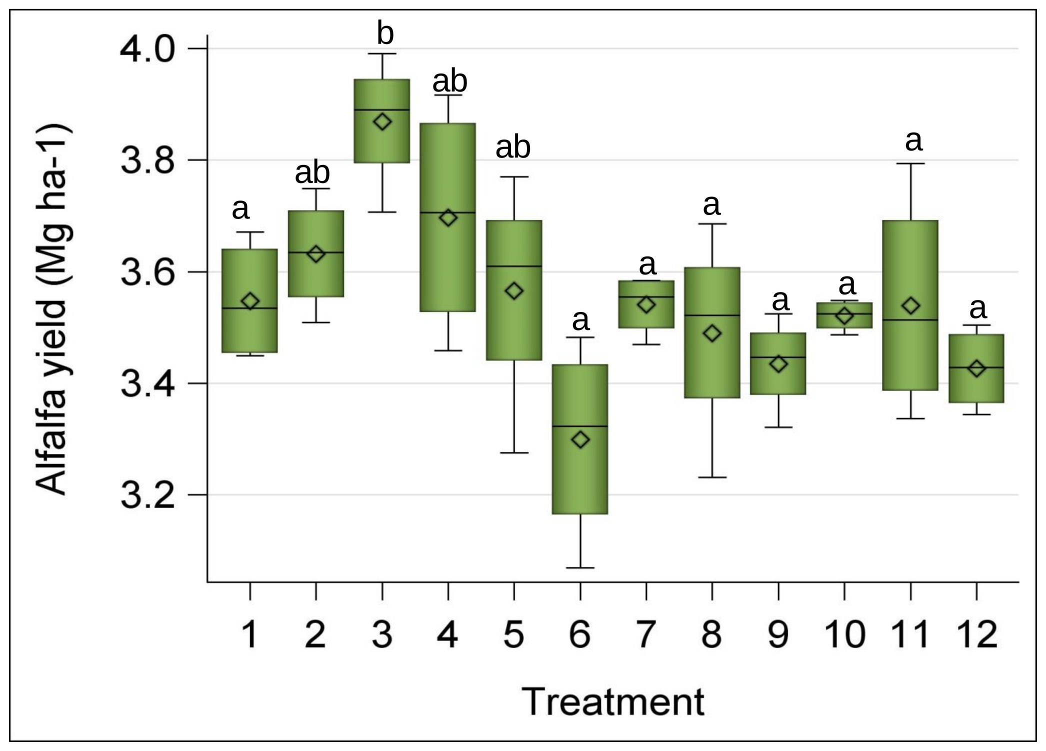

Figure 2. Alfalfa yield per cutting averaged over the first five harvests (treatments with same letters are not statistically different: P>0.1).

- Yields increased with increasing compost rate: 3.55, 3.63 and 3.87 Mg ha^{-1}, for treatments 1, 2 and 3, respectively
- The highest compost rate was the only treatment (#3) that yielded significantly higher (P $\leq$ 0.1) than all mineral fertilizer and control treatments
- Patterns of treatments effect on yield were consistent among all cuttings (data not shown)

- Treatments had no statistically significant effect on soil EC, K and P levels (P = 0.751, 0.688 and 0.694, respectively) (Fig.3)
- Soil analysis of composite and non-replicated soil samples from 15-30cm indicate no increase in EC, K and P levels (data not shown)

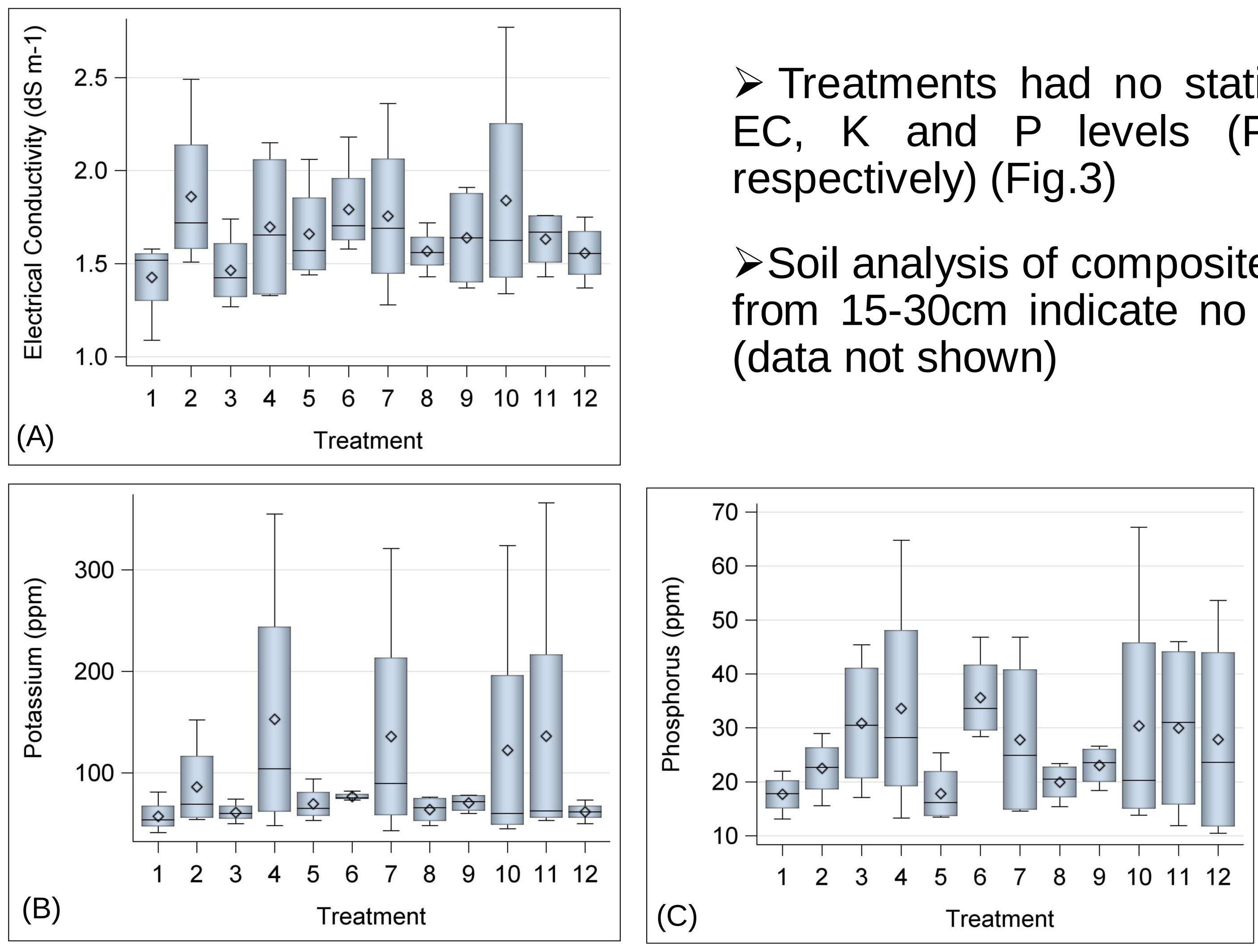

Figure 3. Soil electrical conductivity (A), potassium (B) and phosphorus (C) sampled at the fifth cutting, 0-15cm depth.

Heavy metals

- Plant analysis: The highest compost rate did not significantly increase heavy metal levels (P> 0.165, 156 and 0.641 for Mo, Cu and Zn, respectively). As, Cd, Cr, Pb, Ni and Se levels were below laboratory detection threshold (Table 2)
- Soil analysis: Although the highest rate of compost significantly increased the levels of Cu, Se and Zn (P<0.01) in the top 15cm of the soil, those levels are still considered low

Table 2. Plant and soil heavy metal analysis for samples collected at treatments Number 3 and 12 at the fifth cutting.

		As	Cd	Cr	Cu	Pb	Mo	Ni	Se	Zn
Treatment	Sample type	ppm								
3	Plant	<0.05	<0.05	<0.1	7.53	<0.5	2.88	<1	<0.05	19.45
12	Plant	<0.05	<0.05	<0.1	6.83	<0.5	2.48	<1	<0.05	18.83
3	Soil	1.34	<1	5.00	5.25	2.00	<1	4.25	0.23	21.00
12	Soil	1.38	<1	4.00	3.50	2.00	<1	2.50	<0.10	16.25

CONCLUSION

- ✓ Broadcasting 11.2, 22.5 and 33.7 Mg ha^{-1} of biosolid-compost increased alfalfa yield compared with the untreated control by 3.5, 6.0 and 12.9%, respectively
- ✓ Sufficient nutrient levels in soil nutrient analyses and no yield response to applied mineral P and K fertilizers suggest that the yield increase with the highest rate of biosolid-compost is most likely not due to correction of a nutrient deficiency but rather some other factor such as improved of water retention with compost.
- ✓ Heavy metal content in the plant and soil due to the highest rate of biosolid-compost were similar to the control treatment or slightly higher and well within acceptable levels.