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Arthur Wallace, E. F. Frolich, G. V. Alexander

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EFFECT OF STEAM STERILIZATION OF SOIL ON TWO DESERT PLANT SPECIES

A. Wallace*, E. F. Frolich, and G. V. Alexander

LABORATORY OF NUCLEAR MEDICINE AND RADIATION BIOLOGY

UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIFORNIA 90024

AND THE DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL ENGINEERING

UNIVERSITY OF CALIFORNIA, RIVERSIDE, CALIFORNIA 92502

* A. Wallace, 900 Veteran Avenue

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SHORT COMMUNICATION

Effect of steam sterilization of soil on two desert plant species

Summary

Franseria dumosa Gray and Hilaria rigida (Thurb.) Benth. ex Scribn. seedlings were grown in a glasshouse in potted soil which was collected from the Mojave Desert near Mercury, Nevada. The soil represented areas under living shrubs and also areas between shrubs. Soil was either steam sterilized or not steam sterilized. The sterilization resulted in greatly decreased yields of plants possibly because of induced P deficiency. It was suggested that symbiotic mycorrhizae necessary for P absorption for the species involved might have been eliminated by the sterilization. The effect did not hold for a noncalcareous soil well supplied with available P. Soil sterilization increased both Mn and Zn in plants. There was an interaction in that plants did not grow well in soil from under shrubs regardless of steaming indicating possible allelopathic effects.

Introduction

Other studies in this laboratory had indicated that Franseria dumosa Gray seedlings grew poorly in the glasshouse in soil obtained from the Northern Mojave Desert where this species grows naturally. The purpose of this experiment was to determine if the poor growth could be related to steam sterilization of soil.

Materials and methods

Soil was obtained from near Mercury, Nevada in the Northern Mojave Desert. Soil from under shrubs constituted one test lot and soil from between shrub clumps constituted another. Soil characteristics will be given in a separate report[7]. The soils were highly calcareous and of pH about 8.5. The soil for half the plants was sterilized in a steam autoclave. F. dumosa seedlings or Hilaria rigida (Thurb.) Benth. ex Scribn. seedlings were planted into 2000-g quantities of each kind of soil in a glasshouse with six replicates. Soil moisture was kept near one-third bar by use of distilled-deionized water. After 90 days the plants were harvested, shoots were washed in distilled-deionized water, dried, weighed, and ground for analysis by emission spectrography. There were six replications.

F. dumosa seedlings were also grown with and without steam sterilization in 1000-g quantities of Yolo loam (noncalcareous pH 6) and Hacienda loam (calcareous of pH 7.5). Both are agricultural soils from California and the Yolo especially has a high level of labile P. Plants were grown for 41 days and then handled as above.

Results and discussion

Steam sterilization greatly decreased yields of both F. dumosa and H. rigida (Table 1). Neither species grew as well in soil from under shrubs even though such soil was far more fertile than the soil from the open area. In fact the F. dumosa grew poorly in that soil whether or not it had been steam sterilized. Perhaps a degree of allelopathy[1 3 4 5] may be involved in which toxic substances in the soil from roots of previous plants may decrease the growth of new plants in the same soil.

Steam sterilization resulted in a greatly decreased amount of P in plants (Table 1). This is perhaps the greatest reason for the yield decrease. It could be that the sterilization killed necessary mycorrhizae in soil which are essential to the process of P absorption by some species[2 11]. This may be a satisfactory hypothesis since in another test with a different plant species (bush beans, Phaseolus vulgaris L.) P content of the plant was not decreased by steam sterilization[10]. Unpublished studies indicate that this is so whether they are grown on calcareous or noncalcareous soil.

Increased Mn availability is a well-known phenomenon for soils which have been sterilized by steam[6 8 9]. In the present study Mn was increased, but probably not enough to decrease yields (Table 1).

Zinc contents of both species was increased as result of steam sterilization (Table 2), and this might have had an adverse effect, particularly with H. rigida. Molybdenum content was increased slightly by steam sterilization with H. rigida only. Since sterilization often increases the amount of soluble organic matter[6 8], the effect of Zn and Mo may be related to chelation.

In the experiment with noncalcareous and calcareous agricultural soils, P contents of F. dumosa leaves were not decreased as result of steaming of the noncalcareous soil with a liberal supply of available P, but with the calcareous soil, P was decreased as result of steaming (Table 2). Since this is different from bush beans mentioned above for the same calcareous soil, it appears that the ability to absorb sufficient P is impaired by steam sterilization by some, but not all, plant species when grown in calcareous soil or probably in soil low in available P.

Again this indicates a hypothesis of the need of certain microorganisms.

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A. Wallace, E. F. Frolich, and G. V. Alexander
Soil Science and Agricultural Engineering, Riverside
Laboratory of Nuclear Medicine and Radiation Biology, Los Angeles
University of California USA

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Table Captions

Table 1. Yields and P, Zn, Mn, and Mo contents of plants grown in steam-sterilized and nonsteamed soils from the Northern Mojave Desert (dry weight basis)

Table 2. Yields and mineral composition of leaves of *F. dumosa* grown in a noncalcareous (Yolo) and calcareous (Hacienda) agricultural soils with a mild amount of steam sterilization (dry weight basis)

TABLE 1

Yields and P, Zn, Mn, and Mo contents of plants grown in steam-sterilized and nonsteamed soils from the Northern Mojave Desert (dry weight basis)

	Yield	P	Zn	Mn	Mo
	mg/plant	%	ppm	ppm	ppm
		Franseria dumosa			
		Soil from under shrubs			
Steamed	93	.112	135	193	2.8
Not steamed	89	.225	82	87	2.7
		Soil from open areas			
Steamed	83	.143	177	153	3.6
Not steamed	276	.241	63	53	4.0
LSD .05	41	.028	27	15	NS
LSD .01	55	.037	36	20	NS
		Hilaria rigida			
		Soil from under shrubs			
Steamed	31	.107	381	179	14
Not steamed	373	.164	128	34	9
		Soil from open areas			
Steamed	81	.051	499	216	17
Not steamed	707	.239	72	90	11
LSD .05	137	.056	57	19	2.1
LSD .01	180	.074	75	25	2.7

TABLE 2

Yields and mineral composition of leaves of F. dumosa grown in a noncalcareous (Yolo) and calcareous (Hacienda) agricultural soils with a mild amount of steam sterilization (dry weight basis).

Soil and treatment	Shoot yield	P	K	Mn	Zn	Cu	Ni	Pb	Fe	Ca
	mg/plant	%	%	ppm	ppm	ppm	ppm	ppm	ppm	%
Yolo	283	.31	2.43	151	31	5.1	1.1	6.7	41	2.27
Yolo steamed	450	.34	2.73	254	35	7.3	1.2	7.7	52	2.09
Hacienda	37	.13	1.62	84	43	8.2	2.2	20.2	70	5.76
Hacienda steamed	41	.08	1.42	303	36	7.8	2.2	22.7	63	5.30
LSD .05	112	.05	0.32	62	6	1.2	0.3	3.4	20	1.22
LSD .01	148	.07	0.42	82	8	1.6	0.4	4.4	26	1.59