Response of Barley and Wheat to Sewage Sludge Loading Rates

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ABSTRACT

A greenhouse experiment was conducted to evaluate the responses of barley and wheat to sewage sludge loading rates of 150 to 750 lb/acre plant-available N and to recommended inorganic N (150 lb/ acre). All sewage sludge rates delayed maturity in both barley and wheat. Sludge loading rates up to 450 lb/acre of plant-available N increased vegetative growth and grain yield in both crops. Sludge rates higher than 450 lb/acre of plant-available N resulted in a reduction in the number of plants per pot; however, the stand reduction was greater for wheat than for barley.

INTRODUCTION

There is great interest in the use of agricultural lands as alternative sewage sludge disposal sites. In Arizona, sewage sludge is applied to agricultural lands according to guidelines established by the Arizona Department of Health Services (ADHS) for minimum environmental pollution.

Agronomic benefits derived from sewage sludge as a source of plant nutrients and soil conditioner have great potential in commercial crop production. The rate of sewage sludge application depends on the nitrogen requirement of the crop, the nature and source of the sewage sludge, soil physical and chemical characteristics, and climatic conditions that affect sludge decomposition and nitrogen mineralization. The objective of this research was to determine the maximum environmentally-safe sewage sludge loading rates for barley and wheat in Arizona.

MATERIALS AND METHODS

In 1987, a greenhouse experiment was conducted at the Campus Agricultural Center to study the effects of sewage sludge loading rates on the vegetative growth and grain and straw yields of barley and wheat. Anaerobically digested liquid sewage sludge (8.7% total N) from the Ina Road Sewage Plant was incorporated into Brazito sandy loam soil (CEC 6-8 meq/100g) to formulate the sludge treatments.

A total of seven treatments were each replicated four times as follows: 1. Check (a soil with no fertilizer applied), 2. Recommended amount of N for barley and wheat (150 lb N/acre from ammonium nitrate), and 3. Liquid sewage sludge in an amount that provided the recommended plant-available N (150 lb N/acre). Treatments 4 through 7: sewage sludge to provide plant-available N in amounts equal to 2, 3, 4, and 5 times the recommended plant- available N, respectively.

Each sludge treatment was mixed with the soil in 5-gallon pots using a cement mixer. The ammonium nitrate was applied one-inch below the soil surface, prior to planting. Gustoe barley and Aldura wheat were planted on 12/23/86 and thinned on 1/8/87. Nine plants of barley and wheat were established in each pot and watered as needed. Notes on plant survival and growth were recorded throughout the growing season.

RESULTS AND DISCUSSION

Vegetative growth for barley and wheat responded more in vegetative growth to an increase in sewage sludge loading rates than did grain yield (Table 1). Sewage sludge tended to delay maturity and increase tillering and straw yield in both barley and wheat. Increased barley vegetative growth was more pronounced than in wheat.

Sewage sludge loading rates of more than three times the recommended plant-available N level decreased barley and wheat stands in the seedling stage. The decreased wheat stand was larger heat than for barley. Dying seedlings exhibited moisture-stress, chlorosis, and tip-burn, similar to symptoms of salt toxicity. Surviving plants regained vigorous vegetative growth later in the season.

The foregoing observations indicated that high concentrations of soluble salts in the high sludge loading rates caused initial seedling death; however, the excess salts were leached-out of the soil during subsequent watering.

Sewage sludge loading rates of up to three times the recommended plant-available N increased grain yields in both barley and wheat. Sludge loading rates equal to four and five times the recommended plant-available N reduced grain yields in both crops.

The preliminary findings of this study indicated that the growth and yield of barley and wheat from sewage sludge loading rates up to twice the recommended plant-available N were comparable to, or better than, the growth and yield obtained using recommended N from inorganic sources. These results should be complemented with detailed soil and plant quality analyses before environmentally-safe sewage sludge loading rates can be recommended.

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Table 1

Average results of vegetative growth and grain and straw yields from barley and wheat in response to sewage sludge loading rates.

Crop	Tmt. no.	Plant survival	Tillers	Straw yield	Heads	Seed weight	Grain yield
		(no./pot)	(no./pot)	(g/pot)	(no./pot)	(g/1000)	(g/pot)
Barley	1	9 b*	40 a	86 a	38 a	45 a	38 a
	2	9 b	43 a	94 a	40 a	45 a	43 a
	3	9 b	57 b	110 b	46 a	49 a	50 a
	4	9 b	61 b	112 b	51 a	49 a	57 a
	5	8 b	56 b	114 b	52 a	50 a	55 a
	6	6 a	63 b	117 b	52 a	50 a	41 a
	7	7 b	61 b	122 b	56 a	49 a	41 a
Wheat	1	9 b	45 abc	87 a	43 ab	52 bc	37 a
	2	9 b	37 ab	85 a	35 a	51 abc	37 a
	3	9 b	48 bc	88 a	45 ab	55 c	50 b
	4	9 b	50 c	93 a	48 b	48 abc	53 b
	5	8 b	45 abc	91 a	42 ab	51 abc	45 ab
	6	4 a	38 ab	78 a	36 a	41 ab	41 a
	7	3 a	33 a	92 a	33 a	39 a	38 a

*Means between treatments, within columns, followed by the same letter are not different at the 5% level of significance using SNK.