RESIDUAL EFFECTS OF POTATO AND ONION SLUDGE ON WHEAT YIELD

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Summary

Potato sludge, and a mixture of potato and onion sludge, were compared to chemical N fertilizer as a nutrient source for corn production on a bench soil in 1997. The sludges were applied at a rate estimated to result in 200 lb/acre of N available to the corn, based on an assumed 20 percent annual N mineralization rate. The chemical N fertilizer was sidedressed after planting at 200 lb N/acre. Sludge-amended and chemical-N fertilized plots had significantly higher corn forage and corn grain yields than the unfertilized check plots in 1997.

The residual effects on wheat production were examined in 1998. The plots amended with sludge in 1997 had significantly higher wheat yields in 1998 than the plots treated with chemical N fertilizer in 1997 or the unfertilized check plots. The sludge-amended plots had wheat yields equivalent to the yield of the same variety in the Malheur Experiment Station wheat variety trial on better soil which was also fertilized.

Introduction

The processing of potatoes into frozen French fries generates a substantial amount of liquefied refuse. This refuse is partially dehydrated. The result is a sludge the consistency of gelatin (80 percent moisture). Another agricultural industry waste results from the extraction of onion oil from cull onions. The resulting sludge is not dehydrated, and has a liquid consistency. The disposal of these sludges incurs costs to the processors. With increased restrictions and costs of landfill or pond disposal, application of the sludges to agricultural land could be an alternative. To establish guidelines for application, waste-mineralization rates in soil and their effect on crop yields needed to be determined. The land application of the sludges could not only benefit the processors and the environment, but it could also benefit growers by allowing low cost sludge to substitute for chemical fertilizers. Since the onion sludge is not dehydrated, application of pure onion sludge is difficult. The mixture of the potato and onion sludges, however, results in a consistency that is practical for land application. Potato sludge and a mixture of potato and onion sludges were applied in the spring of 1997 to test for effects on field corn yield, quality, and N recovery. The 1998 trial tested the residual effects of the 1997 sludge on yield of spring wheat.

Materials and Methods

1997 Field Corn Trial. The trial was conducted in the same field of Nyssa silt loam and using the same plots used for field corn in 1997 (Shock et al., 1998). The 4 treatments were an unfertilized check, potato sludge, potato/onion sludge mix, and N fertilizer. The experimental design was a randomized complete block with five replicates. The plots were 20 rows wide and 50 feet long.

The sludge application rate was determined by having a target of 200 lb/acre of available N released the first year based on a 20 percent N mineralization rate. The potato sludge had a 20 percent dry matter (DM) content and 5.52 percent N (DM basis) and the mixed sludge had a 11.9 percent dry matter content and 4.83 percent N. The potato sludge was applied at 50 tons/acre (wet weight) and the potato/onion sludge mix was applied at 100 tons/acre (wet weight). The proportion of the sludges in the mix was 44% potato and 56% onion by weight and was based on the annual output of the sludges from the respective processing facilities. The potato/onion sludge mix was prepared by weighing each sludge separately and then mixing both in a Rotomix feed truck (Rotomix Co., Dodge City, KS).

The potato sludge and the potato/onion sludge mix were applied on April 7 using a Terragator applicator (Ag. Chem. Ind. Div., Minetonka, MN) equipped with a Knight "Slinger box" (Knight Manufacturing, Brodhead, WI). The sludge was side discharged from the slinger box and broadcast by flails located in the discharge outlet. The Terragator was calibrated separately for the potato sludge and potato/onion sludge mix.

1998 Operations for Wheat. The field was plowed and groundhogged twice on March 18, 1998. Wheat seed (cv. Penewawa) was planted at 120 lb/acre on March 20. The plots did not receive any nutrient supplement in 1998. Curtail at 1.2 pt ai/acre was broadcast on June 9 for control of broadleaf weeds. The field was furrow-irrigated as necessary. The wheat in the middle 30 ft of each plot was harvested with a NurseryMaster small plot combine on August 10. Subsamples of the whole plants and of the grain were analyzed for total N.

The soil was sampled in 1-ft increments down to 6 ft in each plot in the fall of 1997 and after the grain harvest in 1998. Soil samples were analyzed for nitrate and ammonium. The N balances were calculated by subtracting the postharvest accounted N (crop N uptake plus available soil N after harvest) from the N supply (available soil N in fall 1997 plus N from irrigation water). Nitrogen contribution from the irrigation water was measured to be 1.5 ppm nitrate plus ammonium-N or 8 lb N/acre assuming 2 acre-feet/acre of infiltration.

Results and Discussion

A severe hail storm on July 4, 1998, resulted in leaf damage and some grain shattering. Wheat yields in 1998 were, on average, 50 percent lower than in 1997 because of the hail.

The sludge treatments applied in 1997 resulted in significantly higher wheat yield in 1998 than either the check or the N fertilizer treatments (Table 1). The sludges were applied at a rate estimated to be sufficient to release 200 lb N/acre in 1997, considering a 20 percent annual N mineralization rate. Consequently, a substantial amount of N in the sludge-treated plots could be carried over and released during 1998 and subsequent years. The N fertilizer applied in 1997 would have been depleted by crop uptake or leaching in 1997. The wheat yields of Penewawa in the sludge plots (Nyssa silt loam, bench soil) were close to the yield of Penewawa (57 bu/ac) in the grain variety trial on highly productive Owyhee silt loam soil following the same hail storm at the Malheur Experiment Station in 1998.

The sludge-mix treatment resulted in significantly higher nitrate and ammonium-N in the soil profile in the fall of 1997 than the other treatments (Table 2). Nitrogen uptake by the wheat plants was significantly higher in the sludge plots than in either the check or the N fertilizer plots (Tables 2 and 3). The N balances in the top two feet of soil suggest that N mineralization from the potato sludge released substantial more available N during 1998 season than the other treatments (Table 3).

Literature cited

Shock, C.C., E. B.G. Feibert, M. Saunders, and G. Schneider. 1998. Nitrogen value of potato and onion sludge for corn production. p. 23-28. In Malheur Experiment Station annual report, 1997. Oregon State Univ. Agr. Expt. Sta. Special Rpt. 988.

Table 1. Corn and wheat yield response to the 1997 application of potato sludge, mixed potato and onion sludge, or N fertilizer. Malheur Experiment Station, Oregon State University, Ontario, OR, 1997-1998.

Treatment†	Field corn yield (1997)		Wheat yield after hail (1998)
	12% moisture	30% moisture	
	------ bu/acre‡ ------		--- bu/acre ---
Check	120.4	151.3	21.2
Potato sludge	195	245.1	58.9
Sludge mix§	218.2	274.3	54.7
N fertilizer	196.1	246.5	30.9
LSD (0.05)	31.9	40.1	13.7

†Sludges and N fertilizer were applied in 1997 only.

‡56 lb/bu

§Potato/onion sludge mix ratio, 44/56.

Table 2. Soil N balances for the 0-6 foot depth in response to land application of potato and onion sludges in 1997, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.

Treatment	N supply		Fall N accounting			
	Preplant soil available N (0-6 ft)	Irrigation water N	Fall soil available N (0-6 ft)	Plant N recovery	Accounted N	Balance†
	lb/acre					
Check	230	8	142	76	218	-20
Potato sludge	260	8	159	202	361	94
Sludge mix‡	336	8	171	164	335	-9
N fertilizer	226	8	157	96	254	20
LSD (0.05)	46		NS	62	86	NS

†Based on the difference between all N supplies and fall N accounting.

‡Potato/onion sludge mix ratio, 44/56.

Table 3. Soil N balances for the 0-2 foot depth in response to land application of potato and onion sludges in 1997, Malheur Experiment Station, Oregon State University, Ontario, OR, 1998.

Treatment	N supply		Fall N accounting			
	Preplant soil available N (0-2 ft)	Irrigation water N	Fall soil available N (0-2 ft)	Plant N recovery	Accounted N	Balance†
	lb/acre					
Check	77	8	47	76	122	37
Potato sludge	104	8	60	202	262	150
Sludge mix‡	168	8	67	164	231	55
N fertilizer	83	8	47	96	143	52
LSD (0.05)	31		NS	62	70	76

†Based on the difference between all N supplies and fall N accounting.

‡Potato/onion sludge mix ratio, 44/56.