RHIZOMA PEANUT BASED CROPPING SYSTEMS FOR DAIRY EFFLUENT SPRAY FIELDS[1]

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ABSTRACT

Cropping schemes that efficiently utilize nutrients applied in dairy waste effluent sprayfields is needed to avoid ground water contamination. Three 12 month cropping systems were grown under dairy waste effluent irrigation: 1) corn-forage sorghum-rye (C-FS-R), 2) corn-rhizoma peanut-rye (C-RP-R), and 3) rhizoma peanut-rye (RP-R). With an effluent N loading rate of 403 kg ha^{-1} yr^{-1}, 2-yr mean DM yield was 30.7 Mg ha^{-1} yr^{-1} for the C-FS-R system, 26.2 for C-RP-R, and 17.9 for RP-R. Nitrogen concentration for C and FS ranged from 9 to 14 g kg^{-1} while RP ranged from 24 to 35. The higher N concentration in RP forage compensated for the lower DM yield of the RP-R system, resulting in the highest N removal of the 3 systems.

KEYWORDS

Dairy effluent, effluent sprayfield, cropping system, rhizoma peanut, intercropping, nitrogen uptake.

INTRODUCTION

Importance. A by-product of a dairy operation is an abundant quantity of nutrients, viewed by many as an animal waste product, but used properly can be a benefit to the feed production program of a dairy. Uptake of nutrients by crops sequenced over time is an effective, economical, and environmentally sound means of nutrient management. The most desirable design for any cropping system is one that meets environmental demands by maximizing nutrient uptake by the crops while meeting the needs of dairy producers.

Several cropping systems using traditional crops have been suggested for use on sprayfields. Rhizoma (rhizoma) peanut (*Arachis glabrata* Benth.), a relatively new crop to Florida, is currently being examined for use in effluent sprayfields. Rhizoma peanut is a legume that produces a high quality forage which can be used in a dairy cow ration as a source of protein, fiber, and other nutrients. A rhizoma peanut sod based system in a dairy effluent sprayfield may also have the potential of continuous nutrient recovery over an entire year in addition to the production of a high quality forage. Rhizoma peanut produces a dense underground rhizome/root system which can intercept applied nutrients.

Rhizoma Peanut vs. Grass. In contrast to a legume sod based system, grass grown under abundant summer rainfall conditions and the continuous application of manure effluent, may require added nitrogen fertilizer due to loss of nitrogen leachate. The condition described is ideal for point source pollution of ground water and underscores the potential benefit of a legume sod based spray field system characterized by the production of high quality forage with no additional nitrogen.

METHODS

A waste effluent-cropping systems study was conducted at the University of Florida's Dairy Research Unit near Hague, Florida from March 1993 to March 1995. Three 12-month cropping rotations were compared for their yield potential of high quality forage and ability to prevent groundwater contamination (Fig. 1). The year-round systems consisted of (1) corn, forage sorghum, and winter rye; C-FS-R, (2) corn (planted directly into a rhizoma peanut sod) rhizoma peanut, and rye; C-PP-R. All annual crops were planted using no-tillage equipment.

In the C-FS-R system, corn was no-till planted into rye stubble and harvested in July. Forage sorghum was then no-till planted into existing corn stubble. Following sorghum harvest, rye was planted for the winter season using a no-till grain drill. For the C-PP-R rotation, corn was no-till planted into an established rhizoma peanut sod in March. Exposed to full sun following corn harvest, the peanut produces sufficient forage for a late fall harvest, followed by rye overseeded with a no-till drill into the peanut stubble. Rhizoma peanut was harvested three times during the warm-growing season in the PP-R system followed by rye overseeded into the peanut sod in late fall.

A completely randomized block design consisted of 3 main nitrogen treatments [effluent only (400 kg ha^{-1}), low N (590 kg ha^{-1}), and high N (790 kg ha^{-1})] with the 3 cropping systems as sub-treatments. The low and high N treatments were attained by the uniform application of effluent across all treatments plus ammonium nitrate in split applications on the corn, forage sorghum, and rye during early vegetative growth at levels consistent with the treatment N level. Crops growing in other two cropping systems were fertilized with ammonium nitrate at the same time and N rate as those in the C-FS-R system.

RESULTS AND DISCUSSION

Dry matter yield: Rhizoma Peanut - Rye System. The dry matter (DM) yield (2-yr average) of rhizoma peanut in the RP-R rotation for the effluent only (control) treatment was 13.9 Mg ha^{-1}. Rhizoma peanut in the high N treatment yielded 8% less than the control. The overall average DM yield for the RP-R rotation was 17.7 Mg ha^{-1} yr^{-1} (Table 2).

Dry matter yield: Corn - Rhizoma Peanut - Rye and Corn - Forage Sorghum - Rye. Dry matter yield (2-yr average) for corn planted into rye stubble (C-FS-R) and corn planted into rhizoma peanut sod (C-RP-R) were both 17.2 Mg ha^{-1}. High N on corn increased forage DM yield by 2.7 Mg ha^{-1} for corn into rye stubble and 1.8 Mg ha^{-1} for corn in rhizoma peanut sod. Across all N treatments, the annual DM yield was greater in the C-FS-R system than the C-RP-R rotation. The main difference being the higher DM yield of the forage sorghum which was more than double that of the p. peanut.

Nitrogen removal: Rhizoma Peanut - Rye System. Mean N removal for the 1993 and 1994 RP-R system was 423 kg ha^{-1} for the control with 403 kg ha^{-1} N applied and 477 kg ha^{-1} N removed in the high N treatment with 885 kg ha^{-1} N applied.

Nitrogen removal: Corn - Rhizoma Peanut - Rye and Corn - Forage Sorghum - Rye. Nitrogen removal for corn planted into rye was 199 kg ha^{-1} compared to 208 kg ha^{-1} for corn grown in RP sod. As with the RP-R system, large increases in N removal did not occur with additional fertilizer N being applied. Nitrogen removal by corn increased only 40 kg ha^{-1} in high N plots, although an additional 258 kg ha^{-1} of fertilizer N was applied during the corn season.

If the RP forage between corn rows could be removed, then approximately 34 kg ha^{-1} of N could be added to each C-RP-R. Nitrogen removal by the RP following corn decreased slightly over N treatments with 112 kg ha^{-1} for the control compared to 96 kg ha^{-1} for the high N treatment, due to a small reduction in RP yield. Nitrogen removal by forage sorghum was 90 kg ha^{-1} for the control, increasing to 144 kg ha^{-1} in the high N treatment. Nitrogen removal by the rye was highest in the C-RP-R system due mainly to a significant increased rye DM yield over the C-FS-R system. Nitrogen removal ranged from 64 kg ha^{-1} for the control to 102 kg ha^{-1} for the high N treatment for the C-RP-R system.

Across all cropping systems, N removal increased only slightly with increased loading rate of N. These results indicate that the controls in all cropping systems were close to their maximum potential and efficiency for removing N from the soil. The highest N removal within all three N loading treatments occurred with the RP-R rotation due to the N concentration of RP being 250% higher than that of the corn and forage sorghum. Percentage nitrogen of rhizoma peanut ranged from 2.4 to 3.5 compared to 0.9 to 1.4 for corn and forage sorghum.

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Figure 1
Year-round cropping systems that utilize plant nutrients contained in dairy waste irrigation effluent.

	Months (M A M J J A S O N D J F)
System I	Corn† ------------> Forage sorghum ------------> Rye--------->
System II	R. Peanut -------------------------------> Rye--------->
System III	Corn into R. Peanut -----> R. Peanut ------------> Rye--------->

† Corn and forage sorghum will be harvested for silage. The rye and rhizoma peanut can be harvested as hay or silage.

Table 1
Nitrogen applied to all cropping systems during corn, forage sorghum, and rye growing cycles at the Dairy Research Unit near Hague, Florida during 1993-94.

Crop	N treatment	N applied (lb/acre)
Corn	Control (effl. only)	195
	Low N	195+130=325
	High N	195+230=425
Forage Sorghum	Control (effl. only)	70
	Low N	70+60=130
	High N	70+120=190
Winter rye	Control (effl. only)	95
	Low N	95+40=135
	High N	95+80=175
Total N	Control (effl. only)	360
	Low N	590
	High N	790

Table 2
Annual nitrogen removed by three year-round cropping systems conducted under waste effluent irrigation at the Dairy Research Unit near Hague, Florida, during 1993-94.

Nitrogen treatment	Cropping Systems: Corn F. Sorghum Rye	Corn P. peanut Rye	R. peanut (3 harvests) Rye	Annual nitrogen applied
	lb N/acre			
Control (effl. only)	287	343	378	360
Low N (effl.+ 0.5 N)	353	380	414	590
High N (effl. + full N)	404	389	426	790