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EVALUATING THE EFFECTS OF WINTER MANURE APPLICATIONS

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Summary:

A four-year field experiment compared the amount of nutrients in the runoff from manure applied to snow covered soil. Three residue types were compared; corn, soybean, and alfalfa. Manure was applied at a rate of ten tons per acre when approximately six inches of snow covered the plots. The highest TKN nitrogen concentration occurred with application on alfalfa residue, and the lowest concentration occurred with applications on soybean residue. The study concluded that the best choice for winter manure application was on soybean residue with as little snow as possible present.

Keywords:
Manure, runoff, surface water pollution

Evaluating the Effects of Winter Manure Applications

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ABSTRACT

Runoff quality was measured from manure application to three residues on snow covered ground for four years. Residues were soybean, corn, and alfalfa. The highest concentration of nitrogen runoff occurred on the alfalfa plots, closely followed by the corn, with soybean residue having the least amount of nitrogen. Concentrations averaged less than 1% of the concentration of the raw manure, but were two to ten times the current drinking water standard of 10 ppm as N. Soybean residue was determined to offer the lowest risk to spreading manure because the depth of snow was lowest at the time of spreading.

INTRODUCTION

There is a perception that winter applications of manure causes significant risk to the environment through runoff. Manure generated from small open lots without storage must be land applied in a timely manner to prevent environmental harm from small storage piles. To determine the best location to haul the manure, a study was started in 1994 at the Western Iowa Research Farm to determine the residue, which would produce the least amount of off site problems.

METHODS AND MATERIALS

The study was started in 1994 with three crop rotations; corn-soybeans, soybeans-corn, and continues alfalfa. Each rotation was replicated three times. There were three check plots one representing each rotation, which did not receive manure. When corn was planted on a check plot the plot received 140 lbs. of Nitrogen as urea prior to planting. This was after all runoff samples were collected for that year.

One-third acre plots were established between two terraces, and plot borders were established with a plow to contain the runoff into the lower terrace basin. Plot slopes were 7% between the terraces.

The manure was applied using an end delivery manure spreader at a rate of 10 wet tons per acre to approximately six inches of snow on the plots. When the snow melted, runoff samples were collected in the lower catch basin of each plot.

The samples were then analyzed for nutrient content and compared to the original manure sample.

While the corn and alfalfa plots would hold six inches of snow, the soybean plot was often less, due to the wind blowing the snow off the plot and to the lower height of residue in the soybean plots.

Water was collected in the runoff basins at the lower end of the plots for the first two-runoff events associated with snow melt.

RESULTS AND DISCUSSION

Measured nitrogen runoff concentration as a percentage of the manure applied is presented in Table 1.

Table 1

Nutrient Concentration in Runoff Water as a Percentage of Raw Manure (TKN):

First Runoff Event	**1995**	**1996**	**1997**	**1998**	**Average**
Residue: Corn	.8	.5	.22	1.3	.7
Soybeans	1.4	.38	.14	.73	.66
Alfalfa	.9	1.2	.11	1.5	.93
Average of check plots(no manure)	.4	.06	.05	.77	.32
Second Runoff Event	**1995**	**1996**	**1997**	**1998**	**Average**
Residue: Corn	1.3	.16	.11	.26	.46
Soybeans	.07	.10	.10	.39	.22
Alfalfa	.94	.07	.07	.41	.37
Average of check plots(no manure)	.04	.08	.08	.22	.10

These values indicated that there is a limited amount of manure running off the plots with the high of 1.5-% being the high in 1997 on the alfalfa plots. While the percentages are low, the Nitrate nitrogen concentrations were two to ten times the drinking water standard of 10 ppm as N. Several of the soybean plot samples were below the 10-ppm standard.

Over the four years of this study, the alfalfa plot had the highest percentage loss in the runoff water followed by corn residue. Soybean residue had the lowest loss. This is exactly opposite of the authors thoughts prior to the study. It was surmised that the residue would help hold the manure onto the land preventing loss. Field observation during the runoff events provide an explanation for this occurrence, while the alfalfa does have more residue, it does a much better job collecting large amounts of snow-- (at least six inches), manure is applied on top of this snow pack. As the snow melts from the top down, it carries the manure down the slope between the residue. The soybean residue did not catch as much snow (normally only two to four inches) with some patches of bare ground because of the wind. The manure that is in direct contact with

the soil does not tend to runoff with the melted water. Manure resting on the snow surface would change the surface color causing the snow to melt more rapidly. Spring melting always occurs at the top of the snow where the manure is placed. The greater the snow depth the higher the potential runoff and the more distance between the manure and the soil causing the manure to move down slope. The snow acts a lubricant to direct the manure off the plots into the catch basin. The residue has little effect on catching or holding the manure because it is not in contact with manure and by mass the residue is very small compared with the water mass. Corn residue caught a little less snow than the alfalfa but much more than the soybean residue.

The check plots in years 1995 and 1998 seem to have high concentrations in them. In 1995, there was some suspicion that the berms between the check plots had allowed contamination to over top them. In the summer of 1995, the berms were raised and that is not suspected in any of the following years. Water collected in the terrace below each plot contains erosion and plant residue from the plot. The nitrogen associated within this sediment may be the cause for the higher than expected value in the check plots. The corn plots received 140 lbs. of commercial N fertilizer in the spring and could account for some dissolved nitrogen the following winter-spring runoff.

Crop yields are presented in Table 2.

Table 2

	1995	1996	1997	1998	3 Yr. Average
Corn with manure	168 bu/acre	149 bu/acre	171 bu/acre	169 bu/acre	164 bu/acre
Corn without manure (140 lbs. N as urea)	140 bu/acre	131 bu/acre	156 bu/acre	181 bu/acre	152 bu/acre
Soybeans with manure	42 bu/acre	63 bu/acre	49 bu/acre	66 bu/acre	55 bu/acre
Soybean without manure	48 bu/acre	47 bu/acre	48 bu/acre	61 bu/acre	51 bu/acre
Alfalfa with manure	4.5 ton/acre	4.2 ton/acre			4.4 ton/acre
Alfalfa without manure	4.5 ton/acre	4.4 ton/acre			4.5 ton/acre

Winter Manure Management continued:

The yield data indicated that the manure is supplying the corn field with the needed fertility to match the commercial fertilizer yields. The soybean yields have improved; the three-year average is four bu/acre better than the soybeans without manure.

The alfalfa plots have not shown a response to the manure in this data. The stand has not been good and an infestation of pocket gophers has lowered the overall yield of all plots. In 1997, the stand had less than two plants/ft^2 and was destroyed to try and start over. The plots were reestablished in the fall of 1997 with an oat cover crop. The oats grew but not the alfalfa due to allelopathic affect of the old alfalfa residue.

The residue in the spring of 1998 is the dead oats. Overall the manure is thought to have enhanced yields on the alfalfa in this study.

CONCLUSIONS OF THIS STUDY

1. Manure should be placed on soil and not snow. Soybean residue would be the choice or areas of the field where the snow cover is less.

2. Standing residue has little effect on keeping manure running off.

3. The relative magnitude of manure runoff from winter applications to snow covered land is small. However, the concentration exceeds the drinking water standard by 2 - 10 times.