

Ammonia Nitrogen Loss
From Sprinkler Applications

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Ammonia Nitrogen Loss *from Sprinkler Applications*

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Application of water soluble fertilizer materials through sprinkler systems has become a common practice for many Oregon farmers. OSC Extension Bulletin 774 discusses precautions to follow when applying these materials through sprinkler systems.

The following nitrogen fertilizer materials that supply the ammonium (NH_4) form of nitrogen are commonly applied through sprinkler systems in the Willamette Valley: ammonium sulfate, ammonium nitrate, urea, Solution 32, and ammonium phosphates. In addition, anhydrous ammonia (NH_3) and aqua ammonia have been applied to a limited extent through sprinklers during the last two years. All of these fertilizers except the aqua and anhydrous ammonia are in the form of a salt. These salts dissolve in water to form ammonium (NH_4) nitrogen.

Anhydrous (NH_3) and aqua ammonia also supply the ammonium (NH_4) form of nitrogen when applied in irrigation water. Any fertilizer solution (water-fertilizer mixture) that supplies the ammonium (NH_4) form of nitrogen is subject to volatilization losses of ammonia (NH_3) when applied under certain conditions. A number of these conditions are discussed in this circular.

Two main losses of nitrogen occur when anhydrous and aqua ammonia are applied through sprinkler systems:

- ▶ Ammonia (NH_3) nitrogen volatilizes (escapes into the air as a gas) while the water is traveling from the sprinkler head through the air to the ground.
- ▶ Some ammonia (NH_3) nitrogen will volatilize from the soil surface and from plant foliage during and shortly after irrigation.

At least five conditions will affect the amount of ammonia (NH_3) nitrogen lost by volatilization through sprinkler applications:

- ▶ Air temperatures
- ▶ Water temperature
- ▶ Wind velocity
- ▶ pH (degree of acidity) of the fertilizer-water mixture.

Concentration and type of fertilizer are the main conditions that control pH of irrigation water. This in turn governs the volatilization of the ammonia (NH_3) nitrogen that occurs during sprinkler application.

It has been suggested that lower air and water temperature in the Willamette Valley--especially the lower temperature of well water--combined with lower initial pH of the irrigation water might reduce the loss of nitrogen enough to make the method of application practical. This problem has also been studied in California. **

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** A study discussing nitrogen losses from sprinkler applications was reported in the June 1955 issue of Agricultural Engineering, pp. 298-299.

An experiment conducted during the summer of 1957 evaluated loss of nitrogen with sprinkler applications of anhydrous ammonia. These losses also were compared with those measured in California. No attempt was made to evaluate the loss of ammonia (NH_3) nitrogen from the soil surface.

Procedure

Loss of nitrogen was evaluated when anhydrous ammonia was applied through sprinkler irrigation in the Willamette Valley. Water was used from a storage pond with a 70° F. temperature and from a well with a water temperature of 52° F. Maximum air temperature was 71.6° F. during the day. Concentration of fertilizer in irrigation water varied from 7 to 32 pounds of nitrogen per acre inch of water applied. A slight breeze was blowing throughout most of the two days during the experiment. Irrigated alfalfa and pasture were growing in the two fields where measurements were made.

Catch basins were set up at distances of 10, 20, and 30 feet from each of four sprinkler heads in a lateral irrigation line. All catch basins contained dry boric acid powder added to prevent loss of any ammonia (NH_3) nitrogen.

A sodium chloride solution was added to irrigation water two different times during the experiment to evaluate evaporation loss of water. Increase in concentration of the sodium in the catch basins, compared with concentration of sodium in the sprinkler line provided a direct measurement of evaporation loss of irrigation water. The sprinkler systems had six gallons per minute sprinkler heads and a pressure of 35 pounds per square inch was used throughout the experimental period.

Results

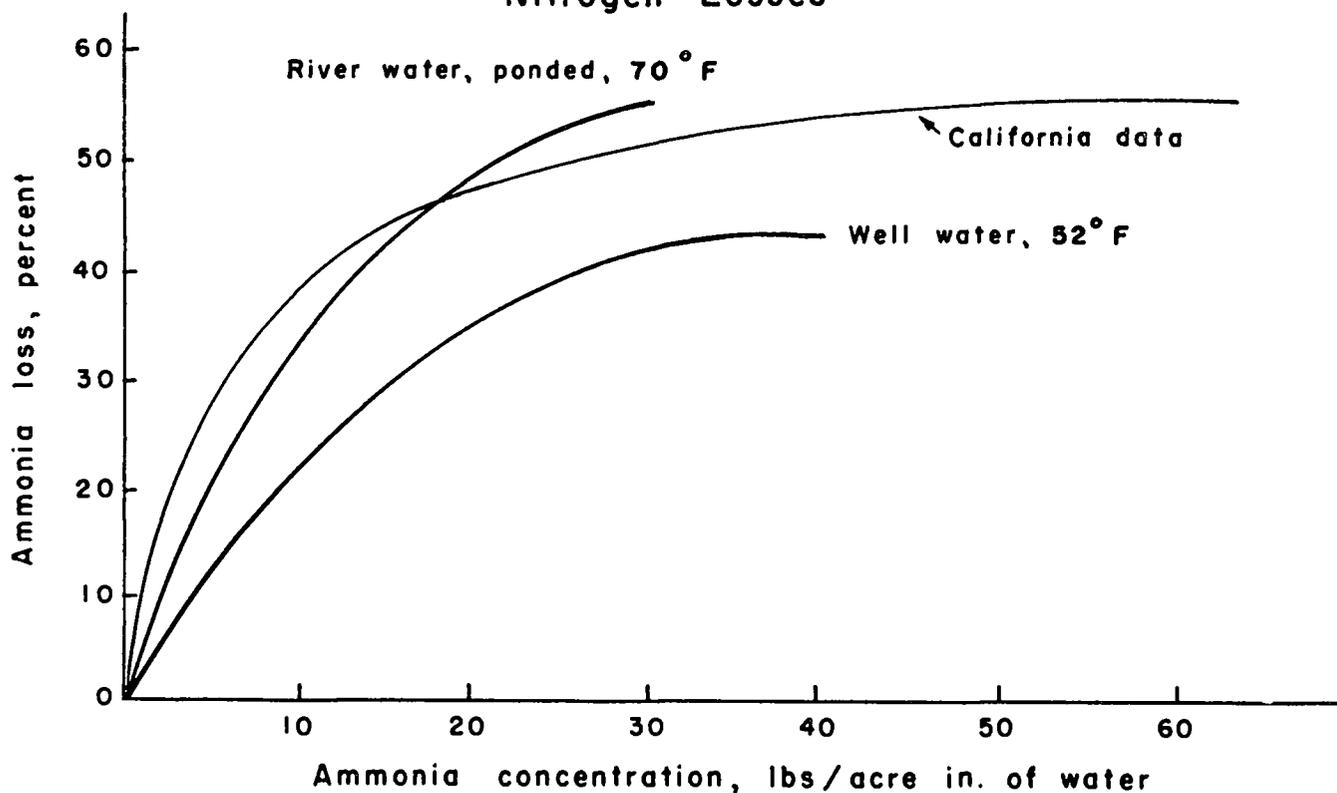
Table 1 shows ammonia losses measured with the two sources of water used in this experiment. The greatest loss takes place nearer the sprinkler heads and decreases with distance. This is true regardless of the rate of ammonia applied or the temperature of the irrigation water. It could be associated with droplet size, since a larger proportion of small drops fall near the sprinkler. Loss of ammonia increases with concentration and the increase is approximately of the same amount regardless of distance from the sprinkler head. Ammonia loss apparently levels off when it is applied at rates higher than 25 pounds per acre inch. This can be seen by comparing values of 25.5 and 38.5 pounds of NH_3 per acre inch for the well water. Losses were not evaluated above 25 pounds per acre inch for the ponded river water.

These losses are compared to those reported in the California experiment in the graph. Data represent average loss for each concentration of ammonia in Table 1. There is a close relationship between California data and warmer river water data. Loss from the well water is less, although still appreciable.

Table 1. Summary of Ammonia (NH₃) Losses from Sprinkler Application

Concentration of NH ₃ applied lbs/acre inch	Ammonia (NH ₃) loss			
	Distance from sprinkler head			
	10 feet % loss	20 feet % loss	30 feet % loss	Average % loss
	ponded river water, 70° F.			
9.0	33.3	25.7	20.0	26.3
11.0	41.9	40.6	34.9	39.1
19.5	48.4	47.4	43.4	46.4
25.5	60.2	57.5	45.9	54.5
	well water, 52° F.			
11.5	26.4	24.0	21.7	24.0
18.5	36.9	30.6	25.1	30.9
25.5	50.4	44.7	35.4	43.5
38.5	47.4	44.4	36.0	42.6

Effect of Water Temperature and Ammonia Concentration on Nitrogen Losses



With the procedure that was followed, losses were lower than under normal field conditions. In this experiment, ammonia was subject to volatilization only while water was traveling from the sprinkler head to catch basin. In the field, ammonia also would escape from the soil surface. These measurements did not evaluate losses that would occur from foliage or soil surface. Also, none of the increased loss that may have resulted from the fine spray less than 10 feet from the sprinkler head was measured. Finer spray and smaller droplet size mean greater volatilization losses.

Information presented is the result of a preliminary study. No attempt was made to evaluate all losses that might be encountered.

Summary and Conclusions

The California data report little, if any, volatilization loss when the salt forms of nitrogen fertilizer materials are applied through irrigation water at rates of application farmers normally use. For example, if you use eight gallons per minute sprinklers on a 40-foot by 60-foot spacing, and applied 100 pounds of ammonium sulfate per acre during a 30-minute application period, you would be applying nitrogen at the rate of about 130 pounds per acre inch of water. This rate would reduce the pH of the fertilizer water solution below 7.0 and would reduce the loss to an insignificant amount (probably less than 1% or 2%). Sprinkler systems applying the same amount of fertilizer but using smaller nozzles would increase the concentration of the fertilizer solution and reduce the losses further.

According to our data, it would be practical to reduce volatilization losses of nitrogen when anhydrous and aqua ammonia (non-salt forms) are applied through sprinkler systems if:

- ▶ It were feasible to add an acidifying material to the ammonia fertilizers as it is injected into the irrigation line to maintain the pH of the fertilizer solution at 7.0 or lower.
- ▶ If the combination of materials added did not corrode the system or deposit salts in the sprinkler line.

For the present we suggest:

- ▶ Recognize that appreciable amounts of nitrogen are lost while the fertilizer solution travels from the sprinkler head to the soil. These loss figures (table 1) apply only to the aqua and ammonia forms of nitrogen.
- ▶ Recognize that additional losses can occur as water evaporates from the surface of the soil and plants.
- ▶ Calculate the cost of the nitrogen that finally reaches the soil and compare this cost with alternative methods of applying nitrogen.

Steps in Calculating Cost:

1. Estimate losses.
2. Calculate the amount of extra nitrogen that must be added to compensate for such loss.
3. Calculate cost per pound of nitrogen that reaches the soil.

Example

1. Estimated loss is 40%.
2. A desired application rate of 45 lb./A would equal 60% of the amount injected into the irrigation line, since 40% would be lost. $45 \text{ lb./A} \div 60\% \text{ reaching soil} = 75 \text{ lb./A}$ initial application required.
3. $\frac{75 \text{ lb./A}}{45 \text{ lb./A}} = 1.67$ Multiply initial purchase cost per pound of nitrogen by 1.67 to calculate cost per pound of nitrogen required to supply 45 lb./A to the soil.