University of Idaho
College of Agriculture
Cooperative Extension Service
Agricultural Experiment Station

Current Information Series No. 313
January 1976

N-Serve and Its Potential Use in Northern Idaho

Glen A. Murray, *Research Crop Physiologist Department of Plant and Soil Sciences*

N-Serve* is a nitrogen stabilizer that offers potential fertilizer savings to farmers in certain areas of Idaho. This report deals specifically with data from field trials and some commercial trials in northern Idaho.

N-Serve retards the conversion of ammonium nitrogen to nitrate nitrogen by inhibiting the activity of **Nitrosomonas** soil bacteria. The action of N-Serve is highly selective and does not appreciably affect other beneficial biological reactions in the soil.

How Does N-Serve Work?

Ammonium nitrogen converts to nitrate nitrogen in the soil in a two-phase process. The first step, to nitrite nitrogen, occurs by action of **Nitrosomonas** bacteria. The nitrite nitrogen then converts to nitrate nitrogen by action of **Nitrobacter** bacteria. This entire process is called nitrification (Fig. 1).

The nitrification process requires oxygen and some moisture, and above-freezing temperatures. Optimum temperatures are between 80 and 90 F. The process is quite slow at temperatures below 40 F. and under extremely high or low soil moisture conditions. Conversion rates of 12 to 44 pounds of nitrogen per day have been measured when 100 pounds of ammonium nitrogen were added to certain soils.

Another soil process, denitrification, occurs when soils are saturated with moisture and oxygen is low or absent. Nitrate nitrogen is converted to gaseous nitrogen by this process and the gaseous nitrogen can be lost to the atmosphere. Denitrification can occur by the action of anaerobic bacteria (bacteria that do not need free oxygen to function) or by chemical conversion if nitrogen is in the nitrite form (Fig. 2).

*N-Serve is a trademark of The Dow Chemical Company. Chemically, its active ingredient (a.i.) is 2-chloro-6-(trichloromethyl) pyridine. It will be available in two liquid formulations: N-Serve 24, for use with anhydrous ammonia or urea nitrogen fertilizer compositions, and N-Serve 24E for use with aqua ammonia or urea nitrogen. Both formulations contain 2 lb a.i./gal.

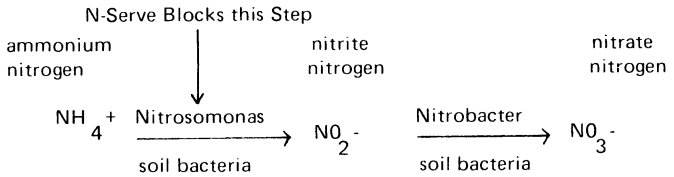

Figure 1 - Nitrification process and N-Serve action.

N-Serve helps stabilize fall-applied ammonium nitrogen by keeping it in the ammonia form. Ammonium nitrogen is held tightly to the soil and cannot denitrify until converted to nitrite or nitrate. Thus, losses by leaching or denitrification are retarded (Fig. 3). Losses of 20 to 40% of added ammonium nitrogen have been measured when conditions for denitrification exist. Losses of 75 pounds actual nitrogen from fall-applied nitrogen have been measured on soils near Reubens, Idaho.

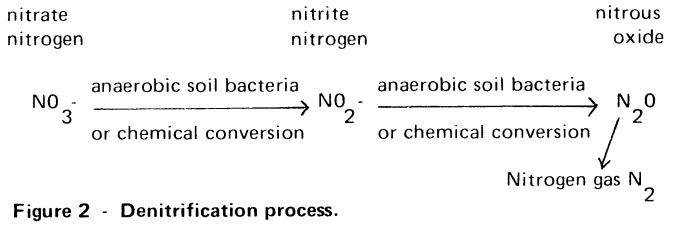

Figure 2 - Denitrification process.

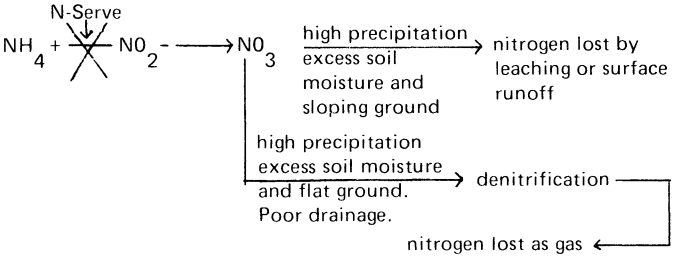

Figure 3 - N-Serve and retardation of nitrogen loss.

How Should N-Serve Be Used?

N-Serve can be applied with anhydrous or aqua ammonia in one operation by directly mixing N-Serve in the ammonia tank. Applications should be made before planting or at planting time in the fall. Note these two requirements:

(1) **N-Serve must be applied with ammonium-type fertilizers.** N-Serve is not effective when applied with fertilizers containing predominantly nitrate nitrogen, nor is N-Serve effective in reducing losses of residual nitrate nitrogen in the soil.

(2) **N-Serve must be incorporated.** When applied with anhydrous or aqua ammonia, incorporation is part of the operation. **NOTE:** N-Serve will not prevent volatilization losses of ammonia from dry, rough seedbeds. The same precautions used for application of ammonia must still be used when N-Serve is applied with the ammonia.

What Rates Should Be Applied?

Both formulations of N-Serve should be applied at rates specified by the label. These rates are ½ to 1 quart of N-Serve/acre which represents ¼ to ½ pound a.i./acre. Based on University of Idaho research, ½ pound/acre appears to be a better rate for use in northern Idaho.

What Crops Can N-Serve Be Used With?

In northern Idaho, the primary crop will be winter wheat. Additional crops on the label are corn, sorghum and cotton. Clearance for use on potatoes and other crops is expected in the future. N-Serve should have some value on irrigated crops of southern Idaho.

Where Will N-Serve Be Valuable?

General areas where N-Serve has potential value are listed in Table 1. These recommendations are based on data from experimental plots and commercial-sized trials (Tables 2-6). All **experimental plots** were fertilized with banded applications of ammonium-type fertilizers with and without N-Serve. Commercial trials were fertilized with anhydrous or aqua ammonia with and without N-Serve. Since concentrated bands of anhydrous or aqua ammonia tend to temporarily sterilize the soil in that band, N-Serve combined with these forms of nitrogen will be more effective than N-Serve applied with dry pelleted ammonium or urea-type fertilizers. Therefore, data presented in this article should be a conservative estimate of the effectiveness of N-Serve.

N-Serve has been most effective when used on forest-type soils which are shallow and have an impermeable silt or clay layer 19 to 24 inches below the soil surface (example, Southwick silt loam). These soils become supersaturated with water above the impermeable layer from fall and winter precipitation. On poorly drained areas, nitrogen can be lost by denitrification. On sloping ground, leaching or surface runoff can cause nitrogen losses. N-Serve will have the greatest potential for use in areas having these general characteristics.

N-Serve has not always been effective in preventing nitrogen loss when temperatures warm the soil rapidly in the spring followed by extremely wet weather. The effect of N-Serve as a nitrogen stabilizer will be low in the spring. As a result, ammonium nitrogen will be converted to nitrate nitrogen as the soils warm up. The nitrate nitrogen will then be susceptible to loss during the subsequent wet spring weather. **No** advantage has been found from using N-Serve on deep soils such as found in the Palouse, Camas Prairie or Kootenai River Bottom areas. N-Serve will be of limited value in areas where nitrogen fertilizer can be applied in the fall with little or no nitrogen loss over winter.

Table 1. General areas and potential for N-Serve use.

Location	Potential for N-Serve use
Areas tested for N-Serve[1]	
Reubens, Gifford, Melrose, Princeton areas	Good (Tables 2,3,4)
Southwick, Cavendish, Frazer, Troy areas	Fair (Tables 2,5,6)
Camas Prairie, Latah County - deep Palouse soils	Poor (Table 2)
Areas not tested for N-Serve[2]	
Worley, Bonners Ferry - benchland	Fair to Good
Rathdrum Prairie, Craigmont area Nezperce, Benewah - near Tekoa	Poor to Fair

[1]Based on commercial and experimental trials.
[2]Based on observations, not data.

Testing N-Serve's Effectiveness

If you wish to test N-Serve for use at your location, take these precautions to assure accurate results:

1. Use N-Serve with appropriate form of nitrogen.
2. Incorporate fertilizer and N-Serve during application.
3. Apply fertilizer - N-Serve combination under the same soil conditions required for the fertilizer alone.
4. Treatments: Use fertilizer with and without N-Serve as well as normal fertilizer treatments in order to obtain a comparison that will show if N-Serve is effective at your location. If phosphorus or sulfur is needed, these nutrients should be added to the entire experiment. Size of individual fertilizer strips should fit application and harvest equipment requirements. Each fertilizer strip should be of the same size and harvested carefully so that accurate yield comparisons can be made. One possible arrangement of plots is:

Fall application of ammonia + N-Serve
Fall application of ammonia alone
Normal fertilizer program used on field

5. Soil test for nitrogen before application of fertilizer in the fall. In the spring, soil sample for nitrogen in each of the fertilizer strips of the test plot. If spring soil tests show low amounts of nitrogen or nitrogen deep in the soil profile in the area treated with N-Serve, N-Serve was not effective in stabilizing the fall-applied nitrogen. Other indications of ineffective stabilization of nitrogen are slow wheat growth and yellow-appearing wheat in the spring after temperatures have warmed the soil sufficiently for good growth.

Table 2. Yield of Nugaines winter wheat fertilized with anhydrous ammonia in commercial N-Serve trials.[1]

Location	Date applied	Yield (bushels/acre) With N-Serve	Without N-Serve	Spring fertilizer
Gifford	9-18-69	67	57	-
Gifford[2]	10-1-70	63	55	63
Southwick[2]	9-17-69	62	48	57
Leland (Potlatch Ridge)	9-17-69	108	106	-
Leland (Potlatch Ridge)	9-17-69	108	114	-
Sweetwater (south of)	9-15-69	72	65	-
Bonners Ferry[3] (District 6)	9-22-71	49	59	-

[1] All commercial trials applied by Mark Means Co. in cooperation with Dr. Don Huber, former University of Idaho plant scientist, and Loren Kambitsch, Nez Perce County agricultural extension agent. N-Serve applied at 1 quart/acre (½ lb. a.i./acre). Unless specified, plots were fertilized with 100 lb. actual N/acre applied as anhydrous ammonia.

[2] At Gifford, fall-application of 16-20-0 provided 30 lb. N/acre and another 70 lb. N/acre was applied in the spring. At Southwick, 24 lb. N/acre was applied in the fall and 90 lb. N/acre in the spring.

[3] Bonners Ferry trial was on Alba wheat treated with 50 lb. actual N/acre applies as anhydrous ammonia. This trial was applied by D and D Service in cooperation with Dr. Glen Murray and Ben Studer, Boundary County agricultural extension agent.

Table 3. Yields of winter wheat fertilized with ammonium nitrogen alone or in combination with N-Serve at Reubens, 1967-68 (wet year).

Treatment	Actual N lb/acre	Yield bu/acre
Control	0	55
Ammonium sulfate (F)	75	66
Ammonium sulfate (F) + N-Serve*	75	76
Ammonium sulfate (S)	75	79
Ammonium nitrate (S)	75	84

F = fall application on October 17, 1967.
S = spring application on May 1, 1968.
* N-Serve applied at 0.5 lb/acre (a.i.)

Table 4. Yields of winter wheat fertilized with ammonium nitrogen alone or in combination with N-Serve at Reubens, 1972-73 (dry year).

Treatment	Actual lb/acre	Yield bu/acre
Control	0	57
Ammonium sulfate (F)	50	58
	80	57
	110	55
Ammonium sulfate (F) + N-Serve*	50	60
	80	57
	110	59
Ammonium sulfate (S)	50	62
	80	61
	110	61

F = fall application on October 6, 1972.
S = spring application on April 11, 1973.
* N-Serve applied at 1.5 lb/acre (a.i.)

Should You Use N-Serve?

Before you decide to use N-Serve, consider these factors:

1. **Effectiveness** — Check Tables 1-6 for potential areas of N-Serve use. Contact your local county agent and dealers for additional information. Consider using experimental plots as outlined previously to provide further information for your area.
2. **Costs** — Fall applications of anhydrous and aqua ammonia are usually less expensive than spring fertilizer applications. N-Serve will probably cost less than $3.50 acre (less than one bushel of wheat).
3. **Time of application** — Fall applications of nitrogen are usually easier than spring applications because of weather and labor demands.
4. **Yield** — Some tests have shown that wheat receiving fall applications of nitrogen with N-Serve may yield a few bushels less than wheat receiving most of its nitrogen in the spring (Table 3).
5. **Other crop hazards** — Some areas are consistently troubled with snowmold, heaving or freezing damage to the extent that entire wheat crops are lost. In these areas, stabilizing high rates of nitrogen might be detrimental to a replacement crop such as malting barley.
6. **Residual soil nitrate-nitrogen** — N-Serve will not stabilize residual soil nitrogen as most of the nitrogen is in the nitrate form.

If residual soil nitrogen or nitrogen applied in the fall is not lost over winter (Table 4) in your area and or is not leached deeply into the soil profile, N-Serve use probably would not be an advantage to you.

Table 5. Yields of winter wheat fertilized with ammonium nitrogen alone or in combination with N-Serve at Cavendish, 1970-71 (wet year).

Treatment	Actual N lb/acre	Yield bu/acre
Control	0	18
	30	21
16-16-16	60	27
	90	36
16-16-16	30	22
+ N-Serve*	60	27
	90	39

* Fertilizer applied on October 6, 1970. N-Serve applied on November 2, 1970, at 1 lb/acre (a.i.)

Table 6. Yields of winter wheat fertilized with ammonium nitrogen alone or in combination with N-Serve at Frazer, 1971-72 (wet year).

Treatment	Actual N lb/acre	Yield bu/acre
Control	0	28
	80	40
Ammonium sulfate (F)	110	49
	140	52
Ammonium sulfate (F)	80	44
+ N-Serve*	110	52
	140	52

* Fertilizer all applied on October 7, 1971. N-Serve applied at 1 lb/acre (a.i.)

Issued in furtherance of cooperative extension work in agriculture and home economics. Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. James L. Graves, Director of Cooperative Extension Service, University of Idaho, Moscow, Idaho 83843. We offer our programs and facilities to all people without regard to race, creed, color, sex or national origin.

4M 1-76