

The Effects of Banding and Broadcasting The Complete Nutrient Requirement for Barley

C.E. Lewis

Associate Professor, Resource Management, Agricultural and Forestry Experiment Station, University of Alaska-Fairbanks

C.W. Knight

Instructor of Agronomy, Agricultural and Forestry Experiment Station, University of Alaska-Fairbanks

B.J. Pierson

Research Associate, Agricultural and Forestry Experiment Station, University of Alaska-Fairbanks

R.F. Cullum

Assistant Professor, Agricultural Engineering, Agricultural and Forestry Experiment Station, University of Alaska-Fairbanks

INTRODUCTION

The fertilizer application method used for producing small grains in interior Alaska is not always a matter of choice but of necessity. Farmers must fertilize, till, and seed a large acreage in a short time to complete the seeding operation no later than the last week in May. In most years, this allows time for the crop to mature before being damaged by autumn frosts. A typical fertilizer application for barley is 380 pounds per acre dry, blended material consisting of 100 pounds urea as the primary nitrogen (N) source, 100 pounds monoammonium phosphate, 100 pounds ammonium sulfate, and 80 pounds potassium chloride. This combination provides an application ratio of 77-51-48-24 pounds per acre N, P_2O_5 , K_2O , and sulfur (S). This means a farmer planting 1000 acres of barley must handle 190 tons of fertilizer material. The most expedient method is to use a 10- to 20-ton capacity, trailer-type, broadcast spreader which minimizes refilling time. If fields are tilled after fertilization, the material is mixed into the soil; otherwise the fertilizer remains on the soil surface.

There are several reasons to investigate other methods of fertilizer application even though this system has worked reasonably well. Most barley produced in interior Alaska is seeded on lands which have been cleared of native vegetation in the last ten years (Lewis and Thomas 1982). Soils are naturally infertile and are cool throughout the growing season (Siddoway et al. 1984), and most have been cropped for only three or four years. Delucchi (1983) reported higher yield response when phosphorus (P) was banded with the seed than when equal applications were broadcast. This is not atypical for P-deficient soils (Cooke 1982). Some farmers in Alaska's interior have begun to band a starter or "pop-up" fertilizer in the row with the seed at the time of planting. Monoammonium phosphate (11 pounds N and 51 pounds P_2O_5 per acre) is typically used. Starter fertilizers banded with the seed render nutrients readily available to the seedlings and may boost plant growth early in the season helping seedlings overcome stress due to cold soil temperatures at planting and during early growth (Veseth 1986, Paul 1987). Yields could potentially be increased and/or fertilizer requirements reduced.

A general rule has been to band no more than 140 pounds per acre total fertilizer containing no more than 15 to 20 pounds N per acre with the seed (Loynachan et al. 1979). Particular caution is urged when urea is used as an N source (Cooke 1982, Robertson 1982). There is a possibility of seedling injury from excessive salts or the release of toxic quantities of ammonia near the seed. Several farmers in the interior of Alaska have banded the total nutrient requirement for barley with the seed using urea as the major N source. Good yield results have been reported for several years with no evidence of crop injury at rates of up to 450 pounds of total material per acre. Delucchi (1983) speculated that in wetter soils, typical of newly cleared lands, salts may tend to dissolve and diffuse away from the seed thereby lessening the potential for seedling damage.

Banding the full nutrient requirement for barley with the seed may increase yields over those found when the equal amount is broadcast, thus increasing returns. Elimination of the broadcast operation will reduce costs slightly. Urea is available locally at a lesser cost than other N sources which must be shipped into the state and may be more cost effective than other formulations.

OBJECTIVES

Alaskan research has not specifically addressed banding the total nutrient requirement with the seed. Repeated inquiries by farmers led to the establishment of research in 1985 to answer the two questions: 1) Can the full nutrient requirement for barley be placed in the row with the seed at the time of planting, eliminating the broadcast operation? and 2) Are fertilizers with an N source other than urea superior in an agronomic and/or economic sense?

METHODS AND MATERIALS

The study was established in interior Alaska at the Agricultural and Forestry Experiment Station research area located at Mile 1408 on the Alaska Highway. The land had been cleared for 7 years and cropped to barley for 3 seasons. Soil in the study area is a Volkmar silt loam (Aeric Cryaquept). The study was located in different areas of the same field in 1985 and 1986. In each year prior to study establishment, the land was cropped to barley, loose straw removed after harvest, and stubble left standing through the winter. The field plot area was disked once in the spring prior to fertilization and seeding.

Two types of fertilizers were compared. One was a homogeneous fertilizer marketed by Chevron under the trade name Unipel®. It is manufactured by mixing plant nutrients in a slurry prior to pelleting so that each pellet contains the nutrients desired. The nutrient ratio of the homogeneous pellet used in this study was 20-10-10-6 (N, P₂O₅, K₂O, S). The N source was ammonium nitrate. The second fertilizer was a dry blend of urea, ammonium sulfate, monoammonium phosphate, and potassium chloride mixed in the same nutrient ratio of 20-10-10-6.

The two fertilizers were evaluated in four placement schemes. All plots received the same amount of total material, 400 pounds per acre. The application methods were: 100 percent broadcast, 40 percent banded and 60 percent broadcast, 60 percent banded and 40 percent broadcast, and 100 percent banded. The study was replicated three times in a randomized, complete block, split-plot design. Individual plots were 6 foot by 50 foot.

Plant counts were made after emergence (the first week in June) and just prior to tillering (mid-June) from three 3-foot strips of row in each plot. Grain from the plots was harvested in early September using a plot combine with a 5-foot header. Moisture content of grain from each plot was measured to indicate crop maturity at harvest. All yields were corrected to a 13 percent moisture basis.

Prices were calculated for each of the fertilizer types used in the study. The homogeneous fertilizer is shipped into Delta from the lower 48 states in bags at a cost of \$335 per ton. The dry blend is available in Delta in bulk for \$264 per ton. The operating costs for broadcasting fertilizer average \$1.28 per acre which includes fuel, labor, and repair and maintenance. Barley price during 1985 and early 1986 averaged \$125 per ton in Delta (Lewis et al. 1987).

Analysis of variance (ANOVA) was used to indicate significant difference in yield and grain moisture as affected by type of fertilizer and method of application. In 1985 and 1986, returns for barley yields were calculated for each type of fertilizer and application method.

RESULTS AND DISCUSSION

The ANOVA indicated barley responded differently to the fertilizer sources in 1985 and 1986. In 1985, the yields from the plots on which the homogeneous fertilizer blend was used were significantly greater ($\alpha = .05$) than those on which the dry blend was used. In 1986, yields from the plots on which the dry blend was used were significantly higher. In 1985, grain from the homogeneous fertilizer plots had a lower moisture content than that from the blended fertilizer plots indicating an advanced stage of maturity. In 1986, no significant differences occurred in grain moisture content. In both years, yields increased as a greater percentage of the fertilizer was banded (see table).

No apparent crop injury was noted from the high rates of banded fertilizer in either 1985 or 1986. In another Alaskan study, Mitchell et al. (1984) reported that the hydrolysis of urea fertilizer was virtually complete within the first 2 to 3 days after application in a Volkmar soil. Prior to hydrolysis, free ammonia is likely to be released into the soil, possibly damaging nearby seedlings. In acid soils such as those found at the study site, any free ammonia released is not likely to move very far before conversion to the nontoxic ammonium form. If this is the case, the probability of ammonia toxicity should be low by the time the barley seeds germinate in these cool soils. If the soil dries sufficiently before the ammonium is taken up by plants or is converted to the nontoxic nitrate form, some may be converted again to the toxic ammonia form.

Table 1. Yields and returns to fertilizer and broadcast application costs for the blended and homogeneous fertilizer sources in 1985 and 1986.

| Treatment | Yield (t/A) | | Returns ¹ (\$/A) | |
|---------------------------|-------------------|--------------|-----------------------------|--------------|
| | Homogeneous Blend | Dry Blend | Homogeneous Blend | Dry Blend |
| 1985 | | | | |
| 100% banded | 1.19 | 0.98 | 81.75 | 69.70 |
| 60% banded, 40% broadcast | 1.14 | 0.91 | 74.22 | 59.67 |
| 40% banded, 60% broadcast | 0.93 | 0.84 | 47.97 | 50.92 |
| 100% broadcast | 0.79 | 0.85 | 30.47 | 52.17 |
| 1986 | | | | |
| 100% banded | 1.71 | 1.85 | 146.75 | 178.45 |
| 60% banded, 40% broadcast | ² | ² | ² | ² |
| 40% banded, 60% broadcast | 1.43 | 1.48 | 110.47 | 130.92 |
| 100% broadcast | 1.30 | 1.46 | 94.22 | 128.42 |

¹Returns at price of \$125/T are calculated using: (YIELD × PRICE) – (FERTILIZER COST) – (BROADCASTING COST).

²Data missing in 1986.

Delucchi (1983) reported no significant plant population reduction from high rates of banded fertilizers on Volkmar soils in interior Alaska. In the current study, significant differences in plant population were found only in 1985 just prior to tillering in plots where 40 percent of the fertilizer was banded. Since this population reduction was not apparent where 70 or 100 percent of the fertilizer was banded, the differences at the 40 percent level were regarded as inconclusive.

Much controversy exists concerning advantages of homogeneous fertilizers. Promotional emphasis has been placed on the fact that each pellet contains all fertilizer nutrients. When a dry, blended fertilizer is used, the plant root must come into contact with three or four different pellets to obtain the same nutrients. If these homogeneous fertilizers are superior to the physical blends, their differences should be apparent in the cool, low-nutrient soils of interior Alaska where germination, root development, and initial seedling growth are slow. In 1985, the seedbed was relatively dry. Precipitation between April 29 and May 20 was 0.92 inches with no measureable amount from May 20 to June 10. During this period the crop was seeded, emerged, and began to develop its root system. The plots fertilized with the homogeneous blend looked vigorous throughout the season and produced higher grain yields than did those fertilized with the dry blend. One might have concluded from the 1985 results that the difference resulted from the greater availability of nutrients in homogeneous pellets during the early part of the growing season when moisture was limiting and root growth was probably slow. However, in 1986 when moisture was more abundant (1.42 inches of precipitation during April 29 to June 10), it would be expected that fertilizer source would have no effect on yield. Instead, the dry, blended fertilizer produced the crop with the highest yield. This phenomenon is not explainable with the present data, but research in succeeding years should provide some insight.

The returns above fertilizer and broadcast application costs for a barley price of \$125 per ton are given in Table 1. The lower cost of the dry blend offset the higher yield of the homogeneous blend only in 1985 when 40 percent of the nutrient requirement was banded. In all other cases in both years, the economic response to fertilizer source followed the yield (agronomic) response. Returns in both years were decreasing as less fertilizer was banded with the seed. The cost of broadcasting fertilizer was a minor portion of the difference in returns found for the two types of fertilizers. The cost differential in using the homogeneous blend versus the dry blend was \$14.20 per acre. If the homogeneous blend had been used, a yield increase of 227 pounds per acre or 4.7 bushels per acre (bushel weight equal to 48 pounds) would have to have been realized to offset this difference (assuming a price of \$125 per ton).

CONCLUDING REMARKS

The two years of research have indicated that neither fertilizer source has caused seedling damage evident in reduction in plant population or yields when amounts exceeding 15 pounds N per acre were banded with the seed. Caution must be expressed in making this statement, however, because exceptionally dry conditions were not encountered at seeding depths during either of the two years of the study. Banding high rates of fertilizer with the seed in such conditions could

lead to total crop failure. Soil moisture at seeding is still regarded by researchers as a critical factor when the decision is made whether or not to band all the fertilizer with the seed.

The type of fertilizer used had an effect on yield in both 1985 and 1986 although no conclusive recommendations can be made at this time concerning fertilizer source. Succeeding years should bring refinements to knowledge of precise effects.

In future work, several fertilizer application rates for banded materials will be included in the design. Recent improvements in grain drill designs allow dry fertilizers to be placed in concentrated bands outside or below the seed row. Studies which include these options may show advantages over the techniques used here.

ACKNOWLEDGMENTS

The authors wish to thank Newton Hawkinson, Technical Sales Representative, Chevron Chemical Company, Kennewick, Washington, for providing the Unipel used in this study. Thanks also to Cathy A. Birkliid for her assistance with the statistical analysis.

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Agricultural and Forestry Experiment Station
School of Agriculture and Land Resources Management
University of Alaska-Fairbanks
James V. Drew, Dean and Director

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