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Guest Editorial
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SUNFLOWER OIL FOR FUEL

G. L. Pratt
Chairman, Agricultural Engineering

Sunflower production in North Dakota has increased from 127,000 acres in 1970 to approximately 2½ million acres in 1980. The 1980 production is down from a 1979 high of about 3½ million acres. Most of the sunflower seed produced has been shipped to Europe for processing into cooking oil. New processing facilities for sunflower oil are now being established in the United States.

Farm production in North Dakota has been hampered recently by occasional shortages of petroleum fuels. Sunflower oil has been suggested as a fuel that would serve as an alternative to diesel fuel during periods of petroleum shortage. Sunflower oil used as fuel could insure a supply of agricultural products if petroleum supplies are unavailable.

Substitution of sunflower oil for diesel fuel is not recommended at present because effects that the oil might have on engine parts have not been determined. Engineers at NDSU have initiated an engine testing program using sunflower oil for fuel and farm operators will be advised when results of the tests are available. A second reason that sunflower oil is not now recommended for fuel is its high cost.

Plants that might serve as oil sources for fuel could include sunflower, soybean, peanut, cotton, rapeseed, safflower, corn, coconut, and palm. One list of 30 vegetable materials suitable for oil production has been published. Sunflower seed appears to be the oil source that is best adapted to North Dakota, as well as many other parts of the country. For example, besides North and South Dakota and Minnesota, Texas is producing a significant amount of sunflower. It also appears to adapt to areas on both coasts. Many other oil crops are more restricted as to areas where they can be grown. Development of sunflower oil as an alternative fuel would make it possible to provide energy for agriculture from renewable sources located close to the area where it would be used.

Technology for commercial extraction of oil from seed is well developed. Processes are largely mechanical and involve types of equipment familiar to farm people. Thus, on-farm production of the oil is conceivable. A second suggested concept is to locate processing plants as cooperative or privately-owned businesses in communities close to the region where the oil will be used.

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In This Issue

On the Cover: One way to capture the energy of the sun is to use sunflower oil for fuel. Dr. George Pratt tells about the potential for sunflower oil as fuel and the research going on at NDSU on the subject in this issue of North Dakota Farm Research. *Photo by Dan Ruud*

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H. R. Lund
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Gary Moran *Dorothea McCullough*

DISCUSSION

Diclofop at 12 and 16 oz/A provided excellent selective postemergence control of wild oat and green foxtail in barley and wheat, resulting in significant wheat and barley yield increases compared to the untreated control plots.

Green foxtail control with 12 and 16 oz/A diclofop was excellent at both stages of application, however, wild oat control with diclofop generally was better with applications at the 2- than 3.5-leaf stage. Data on wild oat control with diclofop indicate that the 12 oz/A rate could be applied at the 2-leaf stage for equal or better control than 16 oz/A at the 3.5-leaf stage. Thus, the stage of wild oat would be important to determine the application rate of diclofop.

Wheat and barley tolerance to postemergence applications of diclofop generally was good, however, in several experiments, slight barley injury was observed with diclofop at the 3.5-leaf stage of application. Hard red spring and durum wheat and barley varieties did not differ in tolerance to diclofop.

Diclofop applied as a tank mixture with bromoxynil controlled broadleaf weeds and weedy grasses with one application. However, diclofop tank mixed with several other herbicides reduced wild oat control with diclofop by 20% or more. Other research conducted at North Dakota State University indicates that applications of diclofop and 2,4-D or MCPA should be separated by more than 1 day (5).

Climatic and soil factors which promote plant growth generally have enhanced wild oat and green foxtail control with diclofop in glasshouse and growth chamber experiments (4). Field observations have confirmed that adequate moisture and fertility enhance wild oat and green foxtail control with diclofop in wheat and barley. These conditions not only enhance diclofop activity, but also promote greater crop competition with weeds.

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Approaches of this kind would keep transportation problems at a minimum.

Most existing oil extraction plants include auger-type expeller units. These machines are designed with an auger in a perforated housing. The center shaft of the auger increases in size from the inlet to the outlet until at the outlet end the shaft is the same diameter as the flighting. As seed moves through the auger, it is compressed until it is forced between this outlet shaft and the auger housing. Oil is forced out of the seed as it is compressed and flows from the machine through the perforations in the housing. Friction caused by the process provides heat so the oil will flow better. Seventy-five percent of the oil from sunflower seed has been extracted by this process.

In most commercial extraction plants, the meal from the auger expeller is exposed to a spray of hexane. This is a solvent that dissolves the remainder of the oil and removes it from the meal to increase the oil yield. Over 99 percent of the oil can be removed from the seed when this process is used. Hexane is then evaporated from the oil and reused.

The complexity of the solvent extraction process makes it undesirable for small on-farm processing plants. Filtration is a necessary step in processing oil as a fuel for diesel engines. The filtration is necessary to prevent fouling of engine fuel systems. Filtering the oil through a 4-micron filter has been recommended as a final process.

Further refining may be desirable to alter the oil characteristics so it will perform well in engines. Commercial extraction plants remove gums by treating the oil with water and then processing it in a centrifuge. Waxes are removed by cooling the oil. Treating the oil with methyl alcohol will produce a methyl ester which also may be used as a fuel. Engine testing is needed to determine if these or other treatments would improve the sunoil as a fuel.

Oil from hybrid varieties of sunflower is commonly 40 percent of the seed including the hull. This compares to 18 percent for soybeans, 17 to 22 percent for cottonseed, 31 percent for peanuts including shells, 36 percent for flax, 30 to 36 percent for safflower and 35 to 44 percent for rapeseed. As a result of the high oil content of sunflower seed, oil yield per acre from sunflower is good.

Meal from processed sunflower shows promise of being a useful feed supplement for livestock. Dr. W. E. Dinusson is conducting a research program in the Department of Animal Science to evaluate this meal. He reports that the protein content for solvent extracted dehulled seed is above 40 percent. This compares favorably with that of other oilseeds such as soybean meal, cottonseed meal, and rapeseed meal.

Dr. Edward J. Deibert is evaluating the meal for possible use as a fertilizer. The nutrient content (nitrogen, phosphorus, and potassium) of the whole seed meal and dehulled seed meal would have an approximate value, based on current fertilizer prices, of $29.40 and $51.72 per ton respectively. He has suggested that the meal could be effectively utilized as a supplemental fertilizer source when other means of disposal are not available.

Dr. D. L. Helgeson and Prof. L. W. Schaffner are conducting economic analyses on processing sunflower oil and on use as fuel. Oil costs have been estimated based on commercial costs of production and a current market value for the meal. Production costs include value of the seed, labor, and equipment. Seed costs at 7.58 cents per pound and a meal value of $86 per ton gave an estimated cost of production of $2.07 per gallon of oil. Labor and equipment cost estimates were included in the analysis.

Dr. H. J. Klosterman of the Biochemistry Department and Dr. D. C. Zimmerman, a biochemist with USDA, have recommended chemical modifications that might be made to the sunflower oil to make it more manageable as a fuel. They are evaluating reports from researchers in the Union of South Africa on the conversion of the oil to methyl ester to provide improved fuel. Viscosity of the methyl ester is improved over that of sunflower oil, but they begin to freeze at temperatures around 32° Fahrenheit. Methyl ester will be incorporated into the engine testing program that is under way at NDSU.

Engine Testing

The potential for success of the system of using sunflower oil as a fuel for diesel engines depends on the performance of the sunflower oil in engines over a long period of time. Profs. Kenton Kaufman and Henry Kucera are involved in testing programs designed to establish these performance characteristics. Potential hazards include varnish buildup in the fuel system, sticking of piston rings, carbon buildup on injectors, excessive stresses on fuel pumps, and contamination of crankcase oil. Tests are needed to determine if these hazards exist and to determine what adjustments might be made to correct the hazards.

The energy content of sunflower oil has been measured at around 130,000 btu/gallon. This compares well with the energy content of diesel fuel at about 138,000 btu/gallon. Sunflower oil is 30 times more viscous than diesel oil at 32°F and therefore will not flow as well. The cetane rating of sunflower oil is 37, which compares favorably with the cetane rating of diesel fuel at 48. For comparison purposes, the cetane rating for gasoline is reported to be about 15 and that of ethyl alcohol is about 7. Sunflower oil weighs 7.7 pounds per gallon and diesel fuel weighs 7.0 pounds per gallon.

A series of short term tests were conducted using a Ford 7000 tractor and an Allis-Chalmers 7010 tractor. Tests on the Ford 7000 with 100% diesel fuel, a mixture of 50% diesel fuel — 50% sunflower oil, and 100% sunflower oil indicated that respective horsepower outputs were 81.4, 79.6, and 75.5. Respective horsepower hours per gallon (Hp hr/gal) were measured at 15.55, 15.02 and 14.8.

Thermal efficiency is defined as the fraction of the heating value of the fuel that is converted into work. The respective thermal efficiencies for the tests were calculated as 31.3, 30.7, and 30.8. The reduced power output from sunflower oil as compared to diesel fuel is about proportional to differences in Btu's available in each fuel. Smoke in the exhaust appeared to decrease slightly at higher percentages of sunflower oil in the fuel. Each test was continued for a duration of less than 30 minutes. Under these conditions, engine deterioration has not been observed.

A complete test program is planned to determine the effects of several hundred hours of operation when sunflower oil is used for fuel. Testing will begin under laboratory conditions. Control of all variables involved in the testing can be maintained in this way. Effects of the oil on engines will be observed throughout the testing. This will be done by such measurements as crankcase oil quality, fuel line pressures and power output. Careful examinations will be made of engine parts if failures occur. At the end of a complete test cycle, engines will be disassembled for evaluation. When satisfactory performance is achieved in the laboratory, field tests in typical farming operations will be initiated.

Average sunflower seed production in North Dakota approaches 1400 pounds per acre. If 75% of the oil can be extracted, oil yield is about 55 gallons per acre. The fuel required to produce one acre of sunflower in eastern North Dakota averages just over 9 gallons. One acre of sunflower can produce fuel for 6 acres of sunflower under these conditions. It has been estimated that one unit of energy is required to produce and process sunflower oil that contains 6 units of energy. The oil therefore appears to be an energy efficient source of fuel.

The economics of vegetable oil production controls supplies around the world at a level that generally has met needs for food. Converting the use of vegetable oils from food to energy will make it necessary to produce more oil crops. Devoting about 10% of existing cropland to energy production would be the maximum required to insure continued agricultural production. Much less will be required if vegetable oils are used for fuels on an emergency basis only. This emergency use could insure agricultural production during times when petroleum was in short supply. Utilization of 10% of cropland for energy production probably wouldn't occur unless the price of petroleum products exceeded the value of sunflower oil.

Extensive research on the use of sunflower oil as a diesel fuel is under way in the Union of South Africa and in Australia. Dr. Graeme R. Quick, a research scientist from Australia, appeared at a seminar at NDSU in March 1980 and reported on his research. J. J. Bruwer is directing a major research effort in the Union of South Africa. He appeared at a seminar at NDSU in September, 1980 and presented a comprehensive report on the work under way in his country.

Most factors related to the use of sunflower oil as a fuel for diesel engines are encouraging. Results of tests on the long term effects of the oil on engines must be obtained and will determine if the practice can succeed or not.

Agricultural Experiment Station
NORTH DAKOTA STATE UNIVERSITY
of Agriculture and Applied Science
University Station
Fargo, North Dakota 58105
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H R Lund

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