

SOIL APPLICATIONS OF SUNFLOWER MEAL AS POTENTIAL FERTILIZER SOURCES

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Once sunflower oil is extracted, a large volume of sunflower meal remains which must be utilized effectively to make on-the-farm processing feasible and cost effective. The meal can be used as a heat energy source (8,000-9,000 BTU/lb), as a feed supplement in livestock and poultry feed rations or as a fertilizer material.

Sunflower meal contains a high portion of nitrogen, phosphorus and potassium and is considered to be an excellent plant nutrient source. The utilization of meal as a fertilizer would be considered an alternative method for disposal of surplus meal. With increased fertilizer cost, utilization of meal by this route may become a reality.

It is well known that the addition of plant material to the soil will improve the physical condition of soil. However, even though the meal contains large amounts of N, P and K, questions remain about the availability of these nutrients to plants. The release of nutrients from sunflower meal through direct solution or by microbial decomposition and mineralization needs to be determined to measure immediate and long term benefits. This study was conducted to evaluate sunflower meal as a potential fertilizer source for the major plant nutrients (NPK).

PROCEDURE

A greenhouse study was conducted during 1981 to evaluate the potential of sunflower meal as a fertilizer source for plant nutrients when applied to the soil. Soil was collected in the fall of 1980 from the plow layer (0 to 6 inches) of a Barnes loam (fine-loamy, mixed Udic Haploboroll) and a Maddock sandy loam (sandy, mixed Udorthentic Haploboroll). Each soil was air dried and sieved through a 4 mesh screen. The chemical characteristics of the soil are listed in Table 1.

Sunflower meal was obtained from the Department of Agricultural Engineering at NDSU where sunflower oil was being extracted from whole seeds with a small screw expeller. The meal contained hulls and some

residual oil. Analysis showed 3.66% nitrogen (N), 1.10% phosphorus (P) and 1.62% potassium (K) or approximately 73, 22 and 32 pounds of nutrient respectively per ton of meal.

The fertilizer value of the meal was evaluated using application rates of 0, 2 and 4 ton/acre in combination with or without commercial fertilizers. Fertilizer rates included 0 + 0 + 0, 120 + 0 + 0, 120 + 30 + 0 and 120 + 30 + 120 lbs/acre of N + P + K applied as ammonium nitrate (34-0-0), concentrated superphosphate (0-46-0) and muriate of potash (0-0-60). Both sunflower meal and fertilizer material were ground in a mortar until they would pass through the 150 mesh sieve. Each sunflower meal and fertilizer treatment was weighed and applied to 4000 grams of soil, then mixed in a rotating V-blender and placed in a plastic lined greenhouse pot.

TABLE 1. Soil Test Levels of Two Soils Utilized To Evaluate Sunflower Meal Applications

Test	Soil	
	Maddock	Barnes
pH (1:1)	7.6	7.2
Organic Matter (%)	2.3	5.7
Total Carbon (%)	1.11	3.47
Total Nitrogen (%)	0.128	0.285
Carbon/Nitrogen Ratio	8.7	12.2
Extractable P (lb/acre)	28	36
Exchangeable K (lb/acre)	304	476
Nitrate Nitrogen (lb/acre)	12	14

Nine hard red spring wheat seeds (variety Kitt) were planted in each pot. After plant emergence the pots were thinned to eight plants per pot. Soil moisture was maintained at field capacity ($\frac{1}{2}$ bar) by weighing each pot every other day and adding the required amount of distilled water. The plants were grown for eight weeks, harvested and dry matter production determined. The experiment was set up in a randomized complete block design with four replications. Pots were rotated on the greenhouse benches at weekly intervals.

After the initial harvest, the pots containing the soil were covered with plastic and left standing in the greenhouse. Water was added at weekly intervals to bring the soil moisture level to field capacity. After six months, Kitt wheat was replanted in the pots of three replications. Six wheat plants were grown to measure residual

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nutrient release. Soil moisture levels were maintained as previously mentioned. After eight weeks, the plants were harvested and dry matter yields measured.

RESULTS AND DISCUSSION

The plant dry matter yield of the Kitt wheat as influenced by sunflower meal alone or in conjunction with various rates of N, P and K is shown in Figure 1. Both soils gave significant responses to applications of 2 and 4 ton/acre of sunflower meal when no additional fertilizer was applied. The Maddock soil gave a larger yield increase with each increment of added meal than the Barnes soil, which was expected because of the lower nutrient status of the Maddock soil. When the Barnes soil received fertilizer applications of N, NP or NPK, only small additional yield increases were obtained with the application of sunflower meal. The 4 ton/acre meal rate applied to the Barnes soil produced the same yield as the fertilized soil.

The Maddock soil produced increased dry matter yields with the addition of each nutrient and increased further with subsequent applications of sunflower meal. The application of 2.50, 3.25 and 4.50 ton/acre sunflower meal produced yields equivalent to the N, NP and NPK fertilizer treatments, respectively (projected from Figure 1). The meal applied at the above rates contained approximately 180 + 55 + 80, 235 + 75 + 105 and 330 + 100 + 145 lb/acre of N + P + K.

Based on current fertilizer prices (N@ 23 cents/lb, P@ 52 cents/lb, and K@ 13 cents/lb) and sunflower meal value (\$110.00/ton for 28% protein), the meal is of more value as a protein feed supplement than as a nutrient source (\$32.50/ton). For example, the 150 lb N/acre fertilizer treatment cost \$34.50 and the nitrogen in the 2.50 ton/acre meal equivalent is equal to about \$42.00. This does not include the value of the phosphorus and potassium in the meal or the beneficial effect of the meal on the physical condition of the soil. Also, the sunflower meal would have some residual nutrient benefit once the undecomposed meal is mineralized in the soil.

A second crop of Kitt wheat was grown on the soils after a six month rest period to measure residual effect of the sunflower meal. Both soils showed an increase in plant growth (yields averaged over the four previous fertilizer treatments) where 2 and 4 ton/acre of meal were previously applied (see Figure 2). The residual response curve for both soils was similar, although the Barnes soil produced higher dry matter yields due to its inherent high fertility level. This study shows some nutrient benefit can be expected in the growth of the second crop due to mineralization and release of N, P and K from previous applications of sunflower meal to the soil. Large field experiments with the inclusion of plant analysis may be required to determine if the results from the greenhouse can be transferred to yield response in the field.

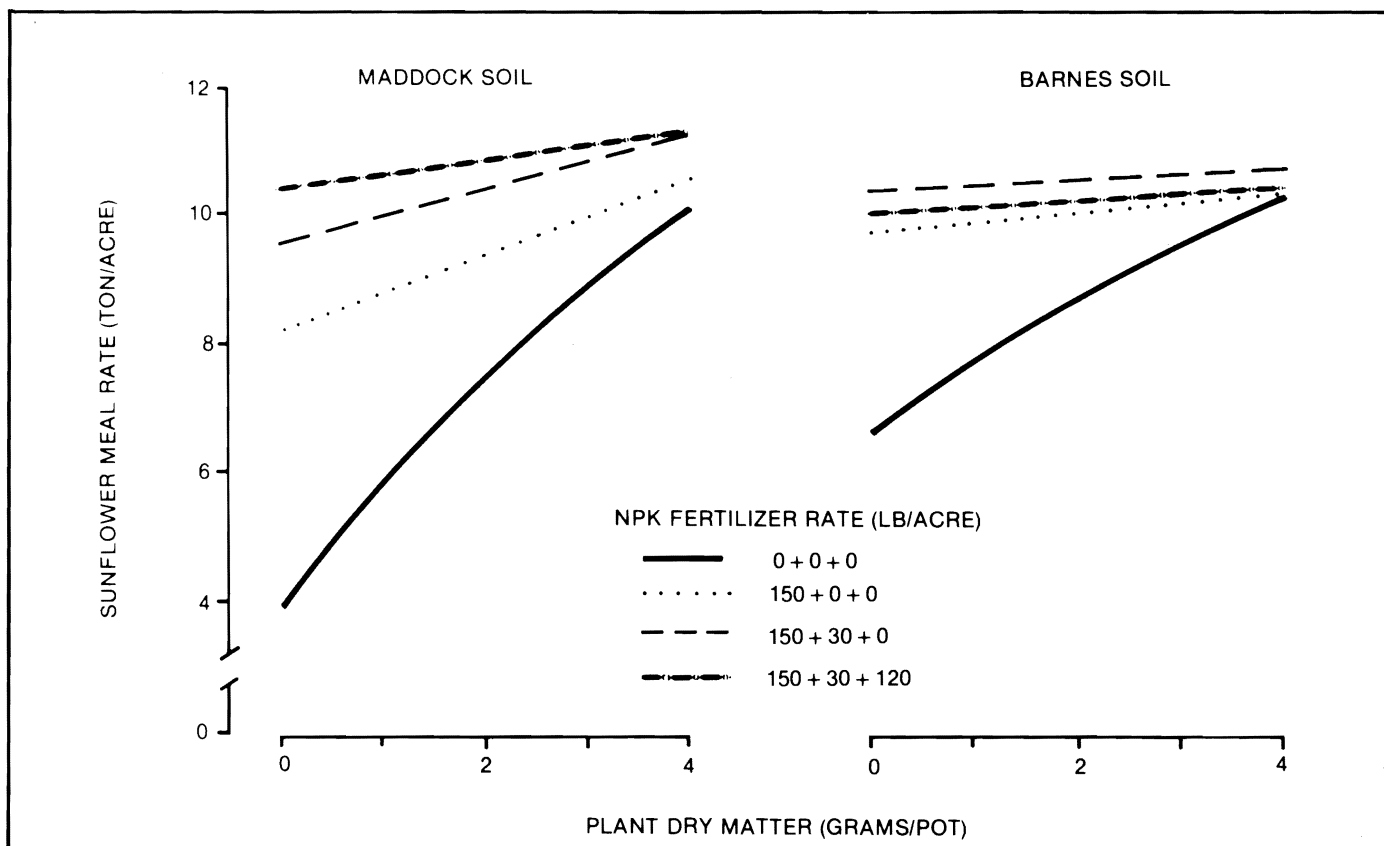


FIGURE 1. Dry Matter Yield of Kitt Wheat as Influenced by Soil Applications of Sunflower Meal.

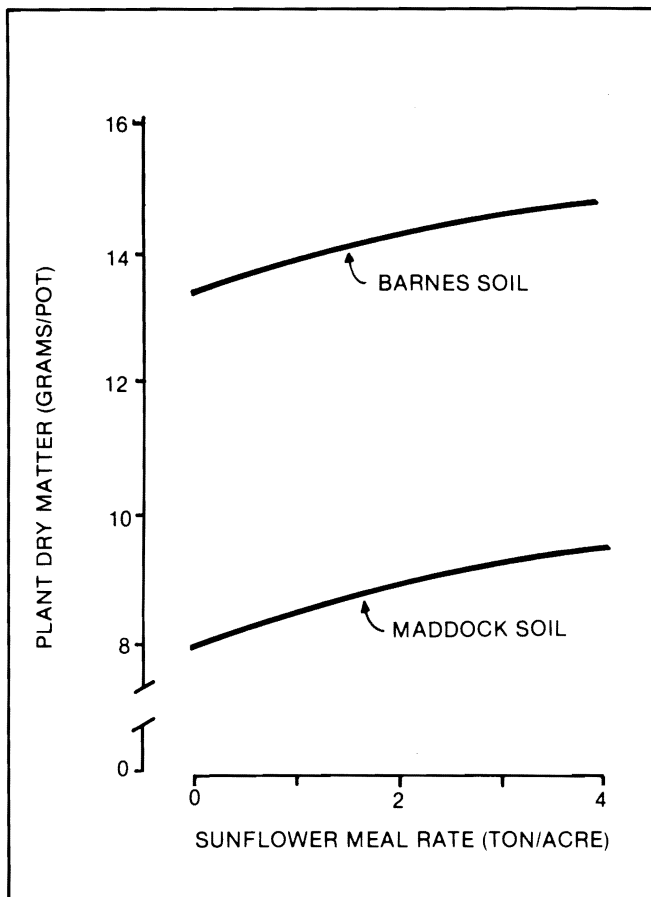


FIGURE 2. Dry Matter Yield of Kitt Wheat as Influenced by Residual Soil Applications of Sunflower Meal (Averaged Over the Four Previous NPK Fertilizer Treatments).

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Before we turn to vegetable oils as fuels, we need to know how much they cost and how much energy it takes to grow and process these plants. Energy ratios have always been controversial when considering biomass energy. Benefits are questioned when crops are grown and fermented to make alcohol. Both positive and negative energy ratios have been reported. On the other hand, vegetable oils are an excellent energy source. The energy output of the crop produced in comparison with the cultural energy input (growing and processing the oil crop) varies between 2.2 and 6.1 to 1.0 depending upon the reference. So, compared to other processes for fuel production from renewable agricultural resources, plant oil production gives a good input/output relationship with considerable net fuel energy output.

The practicality of an alternate farm fuel is dependent on the amount of land required to produce the crop. The average sunflower yield in the United States for the past three years was 1243 pounds per acre. The oil content of the sunflower seed ranges

SUMMARY

The use of sunflower meal as a fertilizer source appears to be an alternative method for utilization of this by product material as evidenced by the response on the two soils tested. The response obtained was greatest on the soil with lower N, P, K and organic matter soil test levels suggesting that maximum benefit would be obtained by applying the sunflower meal to soils of this fertility status. The current dollar value of the sunflower meal as feed far exceeds the value of the nutrients. A three fold increase in current fertilizer prices would make the use of sunflower meal as a soil additive more competitive. Additional field research would need to be conducted to establish application rates over a wider range of soils if the use of sunflower meal as a soil additive becomes a management practice.

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from 40 to 45 percent. Almost all oil in the sunflower seed can be extracted in a commercial operation. Therefore, it is possible to produce approximately 65 gallons of sunflower oil per acre of land. The direct on-farm fuel required to produce an acre of sunflower or small grain in North Dakota ranges from 6 to 9 gallons per acre. Under these conditions, an acre of sunflower could produce enough fuel to grow 7 to 11 acres of small grain or sunflower. About 10 percent of a farmer's land devoted to the production of sunflower could provide his direct on-farm fuel requirements. In 1919, the agricultural acreage devoted to the production of feed for horses and mules in the U.S. was 22 percent of the harvested cropland. We should not be surprised if once again a sizeable percentage of our farm land was devoted to the production of raw materials for the manufacture of fuel, even though it is not to feed horses and mules.

So far the positive aspects of growing plants for their oil have been emphasized, but we have to recognize the problems. No biomass fuel system is perfect, including vegetable oils.

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