Nitrogen, Micronutrient, and Row spacing Response of Sunflowers in a no-till dryland Rotation

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Introduction

The current worldwide demand for edible oils has improved the profitability of sunflowers in the Central Great Plains. Since 1990, the region has had an increase in sunflower planted acres of over 800,000. However, knowledge of sunflower response and fertilizer recovery of N and micronutrients in the region is limited. In a study conducted in western Nebraska (Galeta et al., 1997) researchers measured a sunflower grain yield increase with added N in only one sunflower crop out of 40 tested (2.5%). Similar findings have ben reported by researchers in Kansas and by producers in the region. The objectives of these studies are: (i) to measure N and micronutrient response under no-till managed summer fallow, (ii) to determine N fertilizer recovery of this crop in a wheat-millet-sunflower-fallow rotation as affected by placement, and (iii) to compare narrow row (20") production with conventional (30") row spacing.

Methods

Sunflower were planted no-till into a dryland rotation at the USDA-ARS Central Great Plains Research Station (Akron, Colorado) on a Weld silt loam (2 reps), a Platner silt loam (one rep) and a Rago silt loam (one rep). The experimental design is a randomized split-plot 4-rep experiment. Main plots (Individual plots are 60 ft by 240 ft in size) consist of rotation crop/phase (a wheat-proso millet(or corn)-sunflowers-fallow rotation). Sub-plots (60 by 60 ft in size) are fertilized at N rates of 0, 30, 60, or 90 lbN/acre. Each N rate plot is also divided in half and each half plot is planted in either 20 or 30 inch rows (30 by 60 ft in size). A seeding rate of 16,600 seeds per acre was used for both row spacings. In the 20 inch row plots, 2 rows were sprayed at the 5th leaf stage and at the early-bud stage with zinc, copper, manganese and boron. All phases of the rotation appear every year in each replication. Soil water and inorganic N are monitored at planting and after harvest to assess water and N use efficiency and to evaluate deep N and water extraction by sunflowers.

Surface and deep placed ^{15}N labeled N is being used to evaluate fertilizer N recovery with soil depth and fertilizer recovery with N placement. Total biomass yield and N uptake are measured at petal drop and at near physiological maturity. Grain yield is measured at physiological maturity.

Results

With nearly 6 inches of rainfall in August, of 2000 we measured a significant yield response to added N fertilizer (see table). This is the first sunflower yield response to fertilizer N we have measured at the station on these plots. The four previous years, sunflower yields have ranged between 980 lbs and 1400 lbs regardless of fertilizer N amount. In other words, the check plots to which no fertilizer was added produced about the same amount of grain as the plots fertilized with 30, 60 or 90 lbs of N/acre in all years previous to 2000. Sunflowers respond vegetatively most years. That means a visual green up and an increase in plant size can be observed that increases with N rate, but that response usually does not result in more grain.

From this research, we have determined that sunflowers need about 50 lbs of N/acre per 1000 lbs of potential grain yield. That N can come from residual N left over from previous cropping, or from N mineralization of soil organic matter. The balance in N not met by residual N in the top two feet of the soil profile or from N mineralization of organic matter should be added as fertilizer. Yields were also significantly greater when sunflower was planted in 20 inch rows as compared to 30 inch rows (Table 1). Micronutrients did not significantly increase or decrease sunflower yields, but significantly increased seed oil content in the year 2000.

For two years we conducted a micro-plot study nested into the larger experiment described above. In that micro-plot experiment using ^{15}N- labeled fertilizer, we measured a fertilizer recovery by dryland

sunflowers that was 60% to 65% when the N was banded 4 inch deep, 4 inch away from the row. This means that if 100 lbs of N/acre were applied, 60 to 65 lbs of the 100 lbs applied would be recovered by the crop. The remaining 40 lbs would either be left over as residual N, immobilized by soil microbial biomass, or lost from the system through leaching , volatilization of ammonia or denitrified to N_2 gas. We were surprised to measure 40-50% recovery from fertilizer N placed 2 feet deep. At the 4 foot placement we measured 21-23% recovery of fertilizer N. Only 13-17% recovery was measured at the 5 and ½ foot depth. Broadcast-applied N was used just for comparison. Only an average of 33% of the broadcast N was recovered. And so the broadcast-applied N was only about half as good of a placement method as the subsurface band placed 4 inches deep 4 inches away.

Table 1. Sunflower grain yields and oil contents as affected by N rate, row spacing and micronutrients.

	Row spacing		
N rate	30 inch rows	20 inch no micronutrients	20 inch with micronutrients
lbs/acre	Grain yields (lbs/acre)		
0	1538 (39.2)*	1776 (39.9)	1963 (41.6)
30	2072 (38.0)	2417 (39.3)	2594 (40.4)
60	2090 (37.4)	2682 (37.2)	2556 (38.8)
90	2224 (36.9)	2505 (38.1)	2866 (38.6)

* Values in parenthesis are seed oil contents (%).

The implications of the deep placement study indicate that sunflowers are nearly as efficient at recovering N placed at a two foot depth as they are when fertilizer is placed, more reasonably, in a band 4 inch deep, 4 inches away from the row. One could interpret these results to indicate that, fertilizer N left over from a previous crop year, that hasn't left the top two foot of the soil profile might likely be recovered by sunflowers fairly efficiently. The results indicate an advantage in fertilizer recovery with subsurface banding as compared to surface broadcast applications. The data quantifies for the grower the maximum amount of N (left over from previous fertilization) that a sunflower crop might recover with profile depth to a depth of 5 and ½ feet..

Literature cited:

Geleta S., D.D. Baltensperger, G.D. Binford, and J.F. Miller 1997. Sunflower response to nitrogen and phosphorous in wheat-fallow cropping systems. J. Prod. Agric., Vol 10, no 3, 1997.

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