RATE OF NITROGEN AND PHOSPHORUS FOR SUNFLOWER IN WHEAT-FALLOW CROPPING SYSTEM IN THE NORTHERN HIGH PLAINS

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The primary dryland crop rotation used in High Plains is a wheat-fallow rotation. Some producers, however, grow sunflower *(Helianthus annuus L.)* as one of the potential alternative crops in there field rotations and in years when wheat prices are low. Introduction of alternative crops into the wheat-fallow rotation offers many advantages, some of which include 1) more productive use of land by allowing more than one crop every two years, 2) reduced disease infestation, and 3) reduced weed pressure. Sunflower is one of the major alternative crops considered in the region and planted acres of sunflower has increased significantly in the Northern High Plains region (USDA Economic Research Service, 1994). The recent establishment of a new oilseed processing plant and increased birdseed processing facilities in the region are likely to increase the production of sunflower and other alternative crops in the region.

Lack of moisture is often the factor that limits production in the High Plains and responses to fertilizer are not usually observed in these situations. Current nitrogen recommendations used in the region are adapted from other oil producing states and it suggests sampling to a depth of six feet from the soil surface. Most producers, however, are not willing to sample to six feet because the value of alternative crops does not compensate for the cost and effort involved with the deep sampling. The increase in production, however, will demand appropriate fertilizer nitrogen and phosphorus recommendations and currently there is no database available on the nutrient requirements of the sunflower in the Northern High Plains to meet this demand. The objectives of this research were: 1) To determine the environmental and soil conditions where responses to added nitrogen and phosphorus fertilizers should be expected for sunflower grown in the Northern High Plains, and 2) To determine the probability of predicting a response to added nitrogen fertilizers in sunflower by taking soil samples from varying soil layers and chlorophyll meter reading.

This experiment was conducted at 40 site-years in the Nebraska Panhandle region during 1993 and 1994. The experiment was conducted on-farm under the predominant dryland wheat-sunflower-fallow rotation systems. The experimental design at each location was a split-plot, randomized complete block with three replications. Main plot treatments were two rates of P (0 and 30 lb P a^{-1}) applied as (0-46-0) N-P-K· The sub plots treatments were four rates of N (0, 35, 70, and 105 lb a^{-1}) applied as (34-0-0) N-P-K. All fertilizers were applied broadcast and incorporated shortly after planting. Planting usually occurred + or - 10 days of 5 June. Chlorophyll meter (SPAD-502) measurements were taken peridically during the season to determine if this meter can be used to predict the probability of a nitrogen response in sunflower. The oil contents of the seed were determined from the subsamples of the clean seeds retained from each subplot yield.

Soil samples from each location were collected from 0- to72-in depth at 0- to 6-in, 6- to 12-in, 12-to 24-in, 24- to 36-in, 36- to 48-in, 48- to 60-in, and 60-to 72-in soil layers. At all locations the soil samples were collected just before the application of the fertilizer treatments. The soil samples were analyzed for pH, organic matter, Bray P, ammonium acetate extractable K, and KCl extractable NO_3-N by standard methods of the University of Nebraska Soil Testing Laboratory. Gravimetric soil moisture determination was also made from soil samples collected at the time of planting.

Seed yield, oil content, and chlorophyll meter readings data were analyzed for response to N treatments in the presence and absence of P. However, due to lack of significant effect of P, data were analyzed over P treatment levels. Seed yield and oil content data from the plots that did not receive nitrogen treatments were analysed to see if these characters are influenced by residual nitrate-N. The relationship between sunflower seed yield and precipitation during the period between wheat harvest in July and sunflower planting in June of the year, and for the July and August months during the growing season were analysed. Precipitation data used was from weather stations located within a 20 miles radius of each field.

Findings:

The 1993 sunflower growing condition was wet and cool and the plants encountered early frost. Where as, the 1994 season was dry and plants accumulated growing degree days early in the season that accelarated the growing conditions. These two weather conditions resulted in highly variable yield that ranged from none harvestable to seed yields of over 1900 lb per acre.

Seed Yield*:* Sunflower seeds were harvested from 37 out of the 40 site-years. The yields were evaluated for each site-year and were grouped as high (>1000 lb/a), medium (500 to 1000 lb/a) and low (< 500 lb/a). Seven site-years were grouped as high, 15 as medium, and 15 as low). Since the sunflower yield varied widely, it was necessary to do this grouping inorder to evaluate fertilizer requirement for different yield goals (Fig. 1).

Yield responses to N levels were statistically analysed for each yield group. In the high yield group, significantly higher yield response over the check treatment was obtained at one site only (Table 1). This response was due to the application of the highest N rate (105 lb N per acre) whereas the lower N rates did not have significant impact over the check treatments.

In the medium yield group, application of N had a significant effect on sunflower yield over the check plots at five of the 15 site-years (data not shown). The residual soil nitrate-N level for these site-years was not sufficient to support the level of seed yield harvested. At these five site-years, however, there was no significant difference between the yield of sunflower seed as the result of the levels of applied N fertilizer. The yield levels obtained under the low group was highly variable without statistically significant response to applied nitrogen and phosphorus fertilizer. Regardless of the soil P level that ranged from low to high the presence of phosphorus had no significant effect on sunflower seed yield in the high yield group. In this study several site-years with low soil phosphrus level did not responed to phosphorus fertilization .

Oil Content: Application of increasing level of N consistently decreased sunflower seed oil content. In the high yield group, application of N significantly influenced percent sunflower seed oil content (Table 1). Also, similar effect of N rate on the oil content was observed at the medium yield and low yield groups(data not shown). In all three yield groups, the oil content decreased with increasing application of N levels with r^2 value of 0.96, 0.93, and 0.94 for the high, medium, and low yield group, respectively (Fig. 2).

Chlorophyll Meter Reading: At six site-years, chlorophyll meter readings were increased significantly by application of N (Table 1). In the high yield group, the sunflower seed yield was not significantly impacted by application of increasing rate of nitrogen fertilizer indicating that the increase in chlorophyll unit was not translated into seed yield. Similar results were obtained for the medium and low yield groups.

Residual Soil Nitrate-N Impact: Surface and profile residual nitrate nitrogen level did not significantly influence either the seed yield or the seed oil content. Wide range of seed yields were obtained at similar nitrate-N status suggesting other factors than soil nitrate-N are influencing the sunflower seed yield in the region (Fig. 3). Also, sunflower seed oil content was not significantly influenced by the initial soil nitrate-N at planting time.

Soil Moisture and Precipitation Impact: The amount of precipitation received during the July and August months of the growing season and the amount of precipitation from wheat harvest in July to the time of sunflower planting in July of the following year accounted for only 9 percent of the total variation in sunflower seed yield. Our results did not agree with that of Lyon et al. (1995) who reported positive correlation between seed yield of sunflower and soil water at planting. They also reported that 44% of the yield variability could be accounted for by soil water prior to planting. The yields were highly variable and this variablility was not related to total precipitation or soil moisture content at time of planting.

The results indicate that fertilizer application in the region is not producing expected returns for the yield range up to 1900 pounds obtained in the study. More importantly, the growers will be affected negatively by the declining oil content of the seed. The great varibility in seed yield and lack of response to N and P regardless of the soil nitrogen and phosphorus level indicate that some other factors beside soil nutrients control sunflower seed yield in the region. These factors may include moisture, temperature, and early frost conditions at critical stages during the growing season, and sunflower cultivar.

ACKNOWLEDGEMENTS

The authors wish to thank Rex Nielsen and Jeannie McConkey for their technical assistance during the experiment.

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Table 1. Analysis of variance for site-year sunflower yield greater than 1000 lb/acre.

		Site-93					Site-94	
Source of Variation	Df	6	10	18	19	20	21	39
		Seed Yield (>1000 lb/acre)						
N	3	NS	NS	NS	NS	*	NS	NS
0 vs N	1	NS	NS	NS	NS	*	NS	NS
35 vs High N	1	NS	NS	NS	NS	NS	NS	NS
		Percent Oil Content						
N	3	*	**	**	***	***	***	**
0 vs N	1	NS	**	**	**	***	**	**
35 vs High N	1	**	*	*	*	*	**	NS
		Chlorophyll Meeter Readings						
N	3	**	NS	NS	NS	NS	*	NS
0 vs N	1	NS	NS	NS	NS	NS	*	NS
35 vs High N	1	***	NS	NS	NS	NS	*	NS

*, **, ***, NS Significant at the 0.05, 0.01, and 0.001 probability levels, and not significant, respectively.

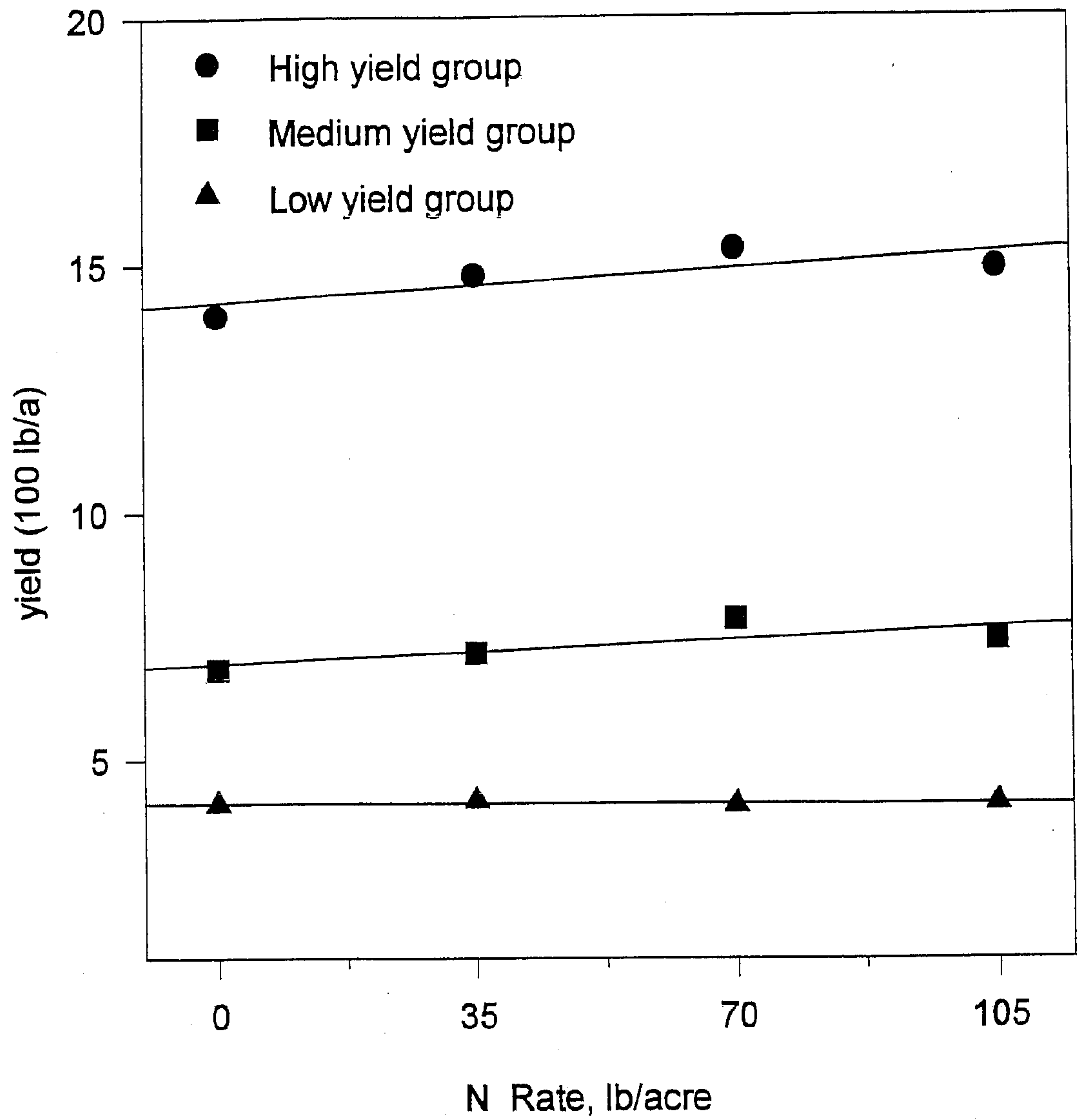

Fig. 1. Sunflower seed yield response to N rate by yield group.

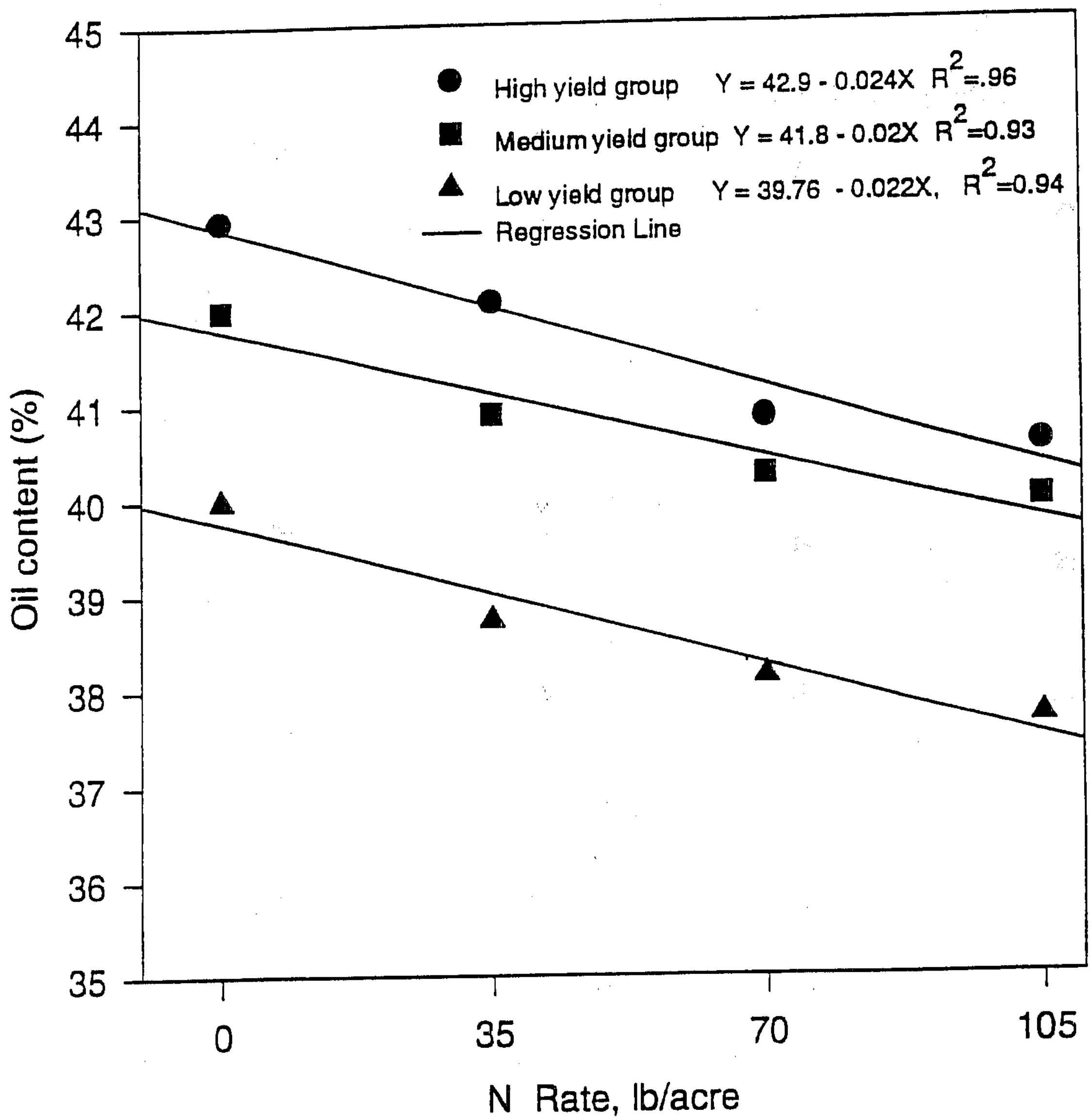

Fig. 2. Sunflower seed oil response to N rate by yield group.

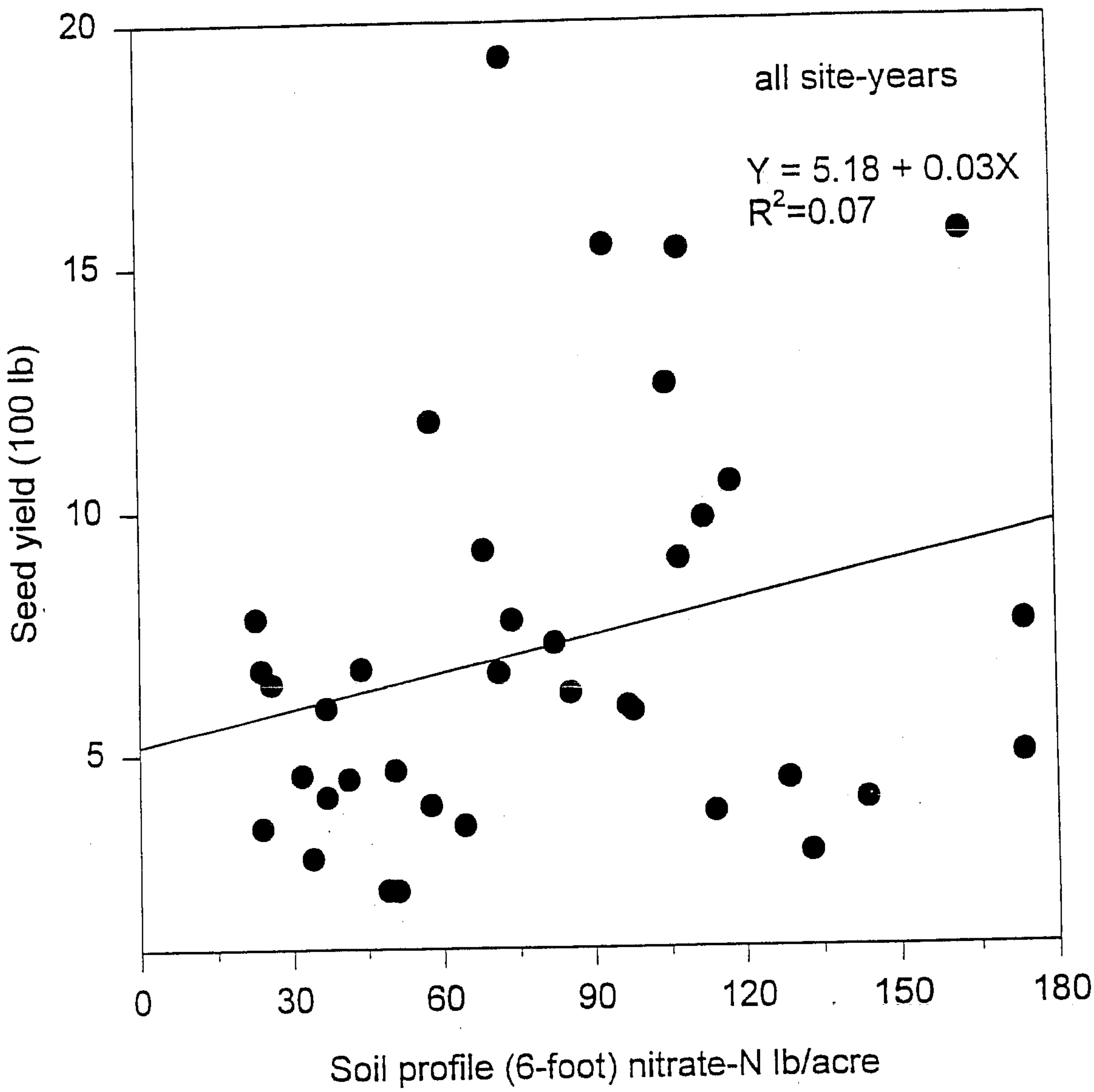

Fig. 3. Relationship between sunflower seed yield of the check plots and soil profile nitrate-N at planting.