Corn Yield Response to N Fertilization

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Objectives:

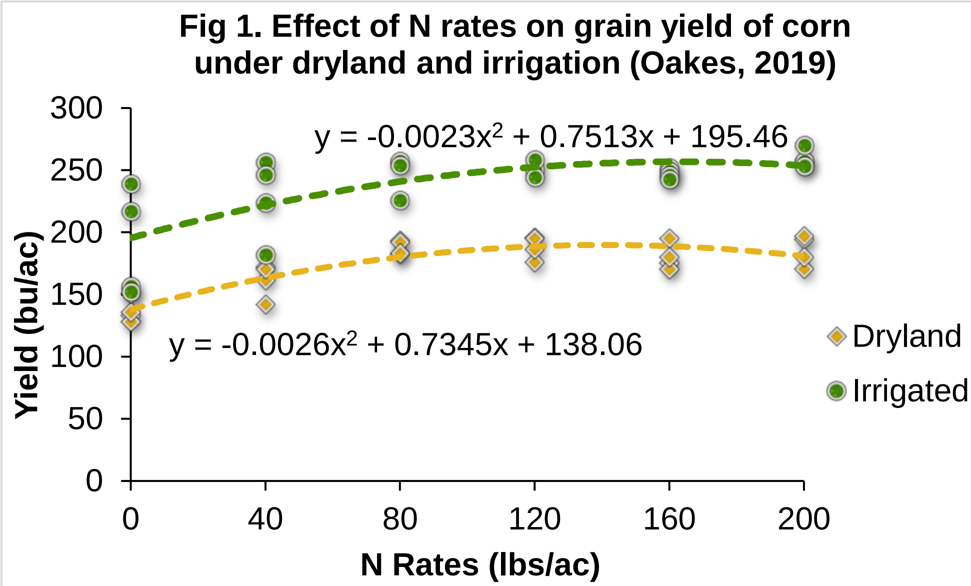
- Assess the impact of N rates on corn yields
- Estimate maximum return to N fertilizer (MRTN)

Methods

Two N response trials were conducted on corn at Oakes under dryland and irrigated conditions, and one at Carrington under dryland (non-irrigated). The N fertilizer treatments were 0 (control), 40, 80, 120, 160, and 200 lbs N at Oakes, and 0, 55, 110, 138 lbs N at Carrington. The two sites at Oakes were strip-till; therefore, urea, the source of N, was applied and left on the surface followed by seeding. Urea was incorporated after broadcasting on the surface at the conventional till site at Carrington before seeding. Soil N tests at the dryland and irrigated Oakes sites were 24 and 38 lbs/ac, respectively, and 14 lbs/ac at Carrington. Soybean was the previous crop at Oakes; meanwhile, corn followed corn at Carrington. Grain yield, test weight, and grain protein data were collected. Maximum return to N fertilizer (MRTN) was calculated for each treatment that received N fertilizer at the Oakes sites, using price of N fertilizer estimated at $0.30/lb, and the price of corn grain at $3.70/bu. Farm gate cost of $6.25/ac was subtracted from the total cost of application of urea. MRTN was calculated by subtracting the cost of application (N rate X price of N - $6.25) from total return (grain price X yield differences between fertilized plots and unfertilized plot) and grain price.

Results

At Carrington, N application resulted in significant yield improvement. Yields increased linearly with increasing N rates (Figure 1), suggesting that even at the highest N rate applied at 138 lbs/ac, maximum yield was not attained. Very low initial soil N of 14 lbs/ac and microbial immobilization (tie-down) of N applied would explain why available N was low and insufficient. Microbial immobilization would happen because relatively high carbon content in relation to amount of N (C/N ratio) in the previous corn residue causes soil microorganisms to use up available N to break up and use carbon in the residues, thus reducing the amount of N available to the crop. Nutrient analysis of the ear leaves showed that application of N resulted in significant increases of all elements measured (N, P, K, S, Ca, K, Zn, Mn, Fe, and Cu) except boron (B). Test weight (TWT) was low on average (49.7 lb/bu), compared to averages for the site, usually between 54 to 56 lbs/bu. As a result of a prolonged growing season with low fall temperatures and an unusually wet September, grains did not attain full maturity, and because grain moisture at harvest was relatively high (21.5%), TWTs were low. According to researchers from Iowa State University, TWT should increase by about 0.2 lb/bu for each percent moisture reduced, and if the TWT increase is less than 0.2 lbs/bu it is indicative of immature grains.



At Oakes, yields responded significantly to N rates with average yields at the irrigated site greater than the dryland site (Figure 2). Under dryland, the average yield was 173 bushels, compared to 236 bushels under irrigation. Maximum yield of 188 bushels was produced from 80 and 120 lbs N under dryland. This yield was significantly greater than yields at 0 and 40 lbs N, but not different from yields at higher N rates. Despite high numerical yield differences between treatments under irrigation, yields were not statistically different between 0, 40, and 80 lbs N, nor between 40 lbs and higher N rates. This was probably because of high variability within the data. However, average yield at 0 lbs N was significantly less than the yields produced at rates greater than 80 lbs (Table 1).

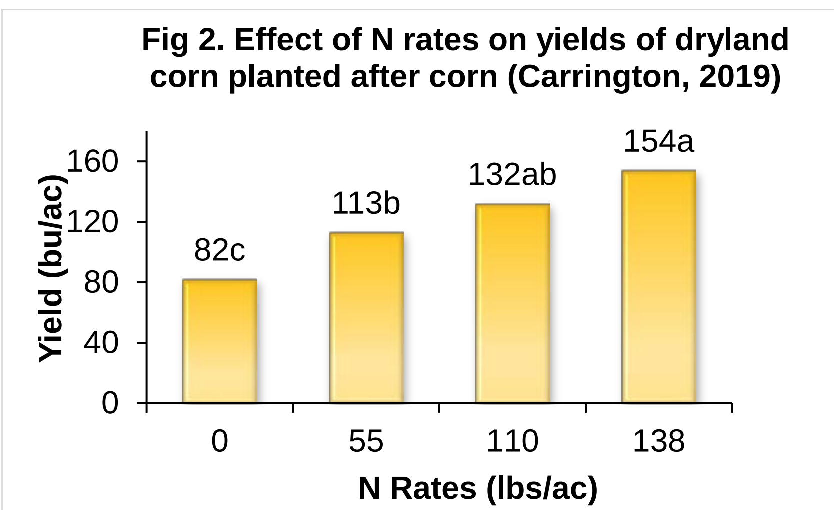


Table 1. N rate effects on corn grain yields, and maximum return to N (MRTN) under dryland and irrigated conditions at Oakes in 2019.

--------------- Dryland ---------------				--------------- Irrigated ---------------		
N Rates	Grain Yield	MRTN		N Rates	Grain Yield	MRTN
lb/ac	bu/ac	$/acre		lb/ac	bu/ac	$/acre
0	137c	-		0	191b	-
40	162b	72		40	225ab	108
80	188a	157*		80	244ab	166
120	188a	147		120	249a	172
160	180ab	105		160	248a	156
200	186a	113		200	262a	196

[ab] Means with different letters indicate significanct difference (95% probability)
Grain price = $3.7/bu; N Cost = $0.30/lb; N applicator rate of = $6.25/ac
* [(188-137)bu/ac x $3.70/bu] - [(80-0)lb N x $0.30/lb N] - $6.25/ac = $158/ac

Under dryland, MRTN was greatest at 80 lbs N with a return of $158/ac. Under irrigation, MRTN was $196/ac at 200 lbs N (Table 1). Even though yield differences were not significant between N rates at 40 lbs and above, the economic return suggested that higher profits were obtained when N fertilizer was applied at 80 lbs or above. The lack of significant yield differences between N rates at 40 and 200 lbs may be attributed to high variability within the data, and contribution of N from soil organic matter and soybean N credit. The MRTN results demonstrate that, MRTN can easily vary by the year and site as a result of changing climatic factors that affect N mineralization, and efficiency of crop N use. This explains why predicting optimal rates of N is difficult to accomplish.

Conclusion

Nitrogen fertilizer significantly improved yields. Obviously, some N contribution from preceding soybean crop or soil organic matter accounted for weak differences in yields between lower N rates and higher N rates. The highest rate of N (138 lb) applied at Carrington was not enough to satisfy the high demands of corn following corn, compared to corn following soybeans, because some of the N applied was likely tied up (immobilized) by soil microorganisms. Even though the estimated MRTN was for a single year and site (understanding that multiple years' data are required to make informed economic N rate decisions), this study showed that MRTN under irrigation was attained at higher N rates than under dryland, probably due to higher yields obtained under irrigation.