# Nitrogen and Phosphorus Nutrition for Semi-Dwarf Castor (*Ricinus communis* L.) Production in West Texas


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## ABSTRACT


In general technical nitrogen requirements have not been established for castor in the United States. Brazil and India report nutrient requirements for castor although the climate, soil types, cultivars, and cultivation techniques are vastly different than regional conditions in the United States. Our objective is to measure yield response to nitrogen fertilization on irrigated castor in West Texas. Field tests were conducted 2010-2011 at two sites in Lubbock, TX (TTU Quaker Farm & TX AgriLife Farm), and 2010 at Pecos, TX, using an RCDB layout with five replications of five treatments (0-40-80-120-160 lbs/A of N added in the form of UAN). Spring soil samples were collected from each plot (0-6", 6-12", 12-24", 24-36", and if possible 36-48", 48-60" depths) and analyzed for nitrate and ammonium nitrogen. The 2011 drought reduced the yields enough to likely overshadow possible significant differences. The 2010 TTU Quaker Farm showed significant increases in yield from the 80 and 120 lbs/A N vs. the 0 lbs/A N treatment (P = 0.05), with soil test to the 36" depth showing an accumulation that averaged around 45 lbs/A of nitrate-N. The 2010 TX AgriLife Farm site soil test results show large accumulations of soil nitrate-N to the depth of 36" averaging near 150 lbs/A, with no significance differences between N treatments. The 2010 Pecos site soil test results also showed large accumulations of soil nitrate-N to the depth of 36" averaging near 250 lbs/A. Yields for this site were low and differences were not meaningful, significant differences between treatments were found between the 0 and 40 lbs/A treatment vs. the 160 lbs/A treatment (P = 0.05). The sites with low levels of rainfall and irrigation showed N treatments ineffective at increasing yield. Test sites with higher levels of rainfall and irrigation show the treatments of 80-120 lbs/A of nitrogen to significantly increase the yield. High subsoil nitrate-N levels masked yield response to nitrogen fertilizers.


## INTRODUCTION

Interest in castor production in the U.S. has been renewed due to the release of a semi-dwarf (3-5', Fig. 1 A&B) reduced-ricin (78-85% less) castor line 'Brigham' (Severino et al., 2012). Using safe handling procedures (Trostle et al., 2012), castor production could soon be back to the US production levels seen in the 1960's. Nutrient requirements have not been established for castor. Traditional soil nitrate sampling recommendations in the past have been to soil sample to a depth of 6" (Provin et al., 2012; McFarland et al., 2012). Studies show that although the 6" depth soil sample is adequate for determining the status of immobile nutrients such as phosphorus or potassium, it is not the best predictor of available N to the crop, and we should consider deeper soil sampling for better prediction values (Shahandeh et al., 2011; Franzluebbers et al., 1994; Booker et al., 2007). Newer recommendations for sampling for nitrate-N to a deeper depth along with other available soil N prediction parameters such as soil clay content, and predictable irrigation/rainfall are now considerations as advancements in precision agriculture occur (Shahandeh et al., 2011). Current castor nitrogen recommendations for the Texas High Plains relies on early nutrient work before the concepts of soil testing for available plant nitrogen. Nitrate-N levels measured to a depth of at least 36" for this study help identify appropriate levels of nitrogen associated with yield response in castor while factoring in possible deep soil nitrate.

## OBJECTIVES

1) Asses soil N in a castor production system;
2) Assess castor response to applied fertilizer N;
3) Determine suitable fertilizer recommendations for castor in West Texas.

## MATERIALS & METHODS

***Soil Type***

This study was conducted at three test sites:

- Texas A&M AgriLife Research & Extension Center, Lubbock, TX: Olton clay loam ( fine, mixed, superactive, thermic Aridic Paleustoll)
- Texas Tech University Quaker Farm, Lubbock, TX: Amarillo-Urban land complex (loamy, mixed, thermic Aridic Paleustalf)
- Texas AgriLife Research Station, Pecos, TX: Hoban silty clay loam (fine-silty, mixed, thermic Ustollic Calciorthid).

***Soil Sampling***

Uniform individual soil samples were taken from each plot. The 0-6" and 6-12" samples were taken using hand-held soil probes (0.5" diameter, 8 per plot) taken from the middle two rows of the four-row plot, alternating from the top to the side of the bed evenly throughout the plot. The 12-24", 24-36", 36-48", and 48-60" samples were taken using a Giddings hydraulic soil probe (Giddings Machine Co., Fort Collins, CO) at 2 cores per plot. Samples were air-dried and crushed to pass through a 2-mm sieve. The samples were stored in Ziploc bags until samples were shipped for soil analysis.

***Soil Analyses***

All soil samples were submitted to Ward Laboratories (Kearney, Nebraska) for analysis. Nitrate-N levels were determined by extracting the soil with 2M KCl and then using a Lachat system (Ward Laboratories Inc, Kearney, Nebraska).

***Fertilizer Application***

The liquid fertilizer N treatments were applied ~30 days after planting using a four-row coulter liquid variable rate application system controlled with a Dickey-John controller. Fertilizer was applied using a side-dress technique of 6 inches to the side of the plants and 6 inches deep. Liquid nitrogen fertilizer was applied using UAN (urea ammonium nitrate) 32-0-0 at the treatment rates of 0, 40, 80, 120, and 160 lbs/A of nitrogen.

***Statistical Analysis***

Statistical analysis was conducted using SAS version 9.2, Mixed Proc that includes Differences of Least Squares Means, for determination of statistically different treatments.

## RESULTS

***Soil N Levels***

Substantial castor yield was achieved when no fertilizer N was added due to significant levels of soil N at some sites (Fig. 2). Rainfall + irrigation indicated that each inch of moisture on a season-long basis produced about 68 lbs. of castor yield. The high soil nitrate-N levels, however, were sufficient to supply significant castor growth, even above 1,000 lbs./A when moisture was available. Excessive amounts of N (>100 lbs. N/A) were observed at TX AgriLife Lubbock, 2011 and Pecos 2010 which is likely due to accumulation from over fertilization or minimal crop growth in earlier years. (we saw a sharp increase in yield of the test sites due mainly to increasing levels of available irrigation/rainfall.

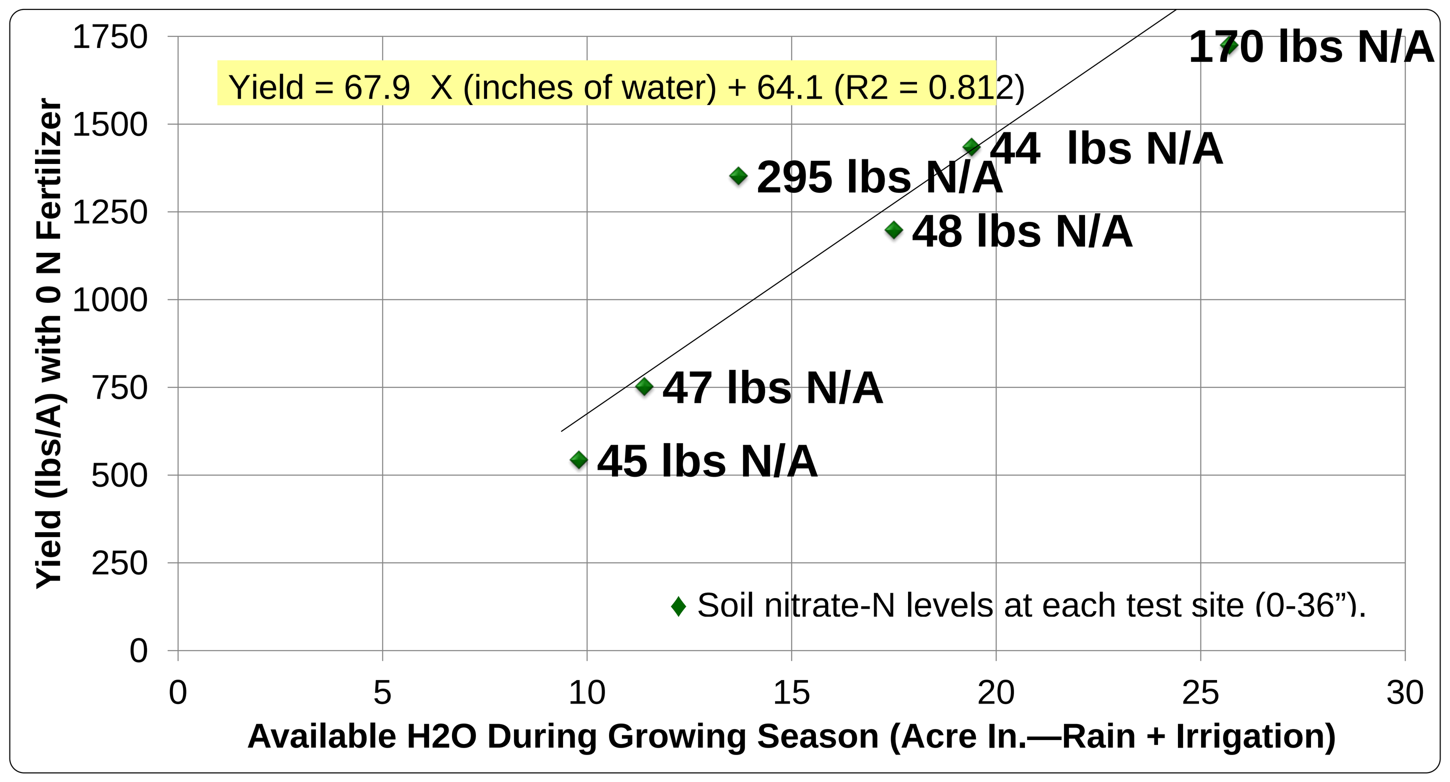


**Figure 2. Castor yield vs. sum of (rainfall + irrigation) for six test sites when no fertilizer N was added. Soil nitrate-N levels for 0-36" soil depth are noted for each site.**

***Castor Yield and N***

Overall, due to much greater than expected soil nitrate-N, only two of six sites showed any significant response to applied N. One site, Quaker Farm, 2010, indicated small statistical response to applied N, but the yields tailed off at higher N levels, and actual fertilizer N response was minimal (Fig. 3.). High levels of soil N readily preclude castor response to N as would be expected (Fig. 4).

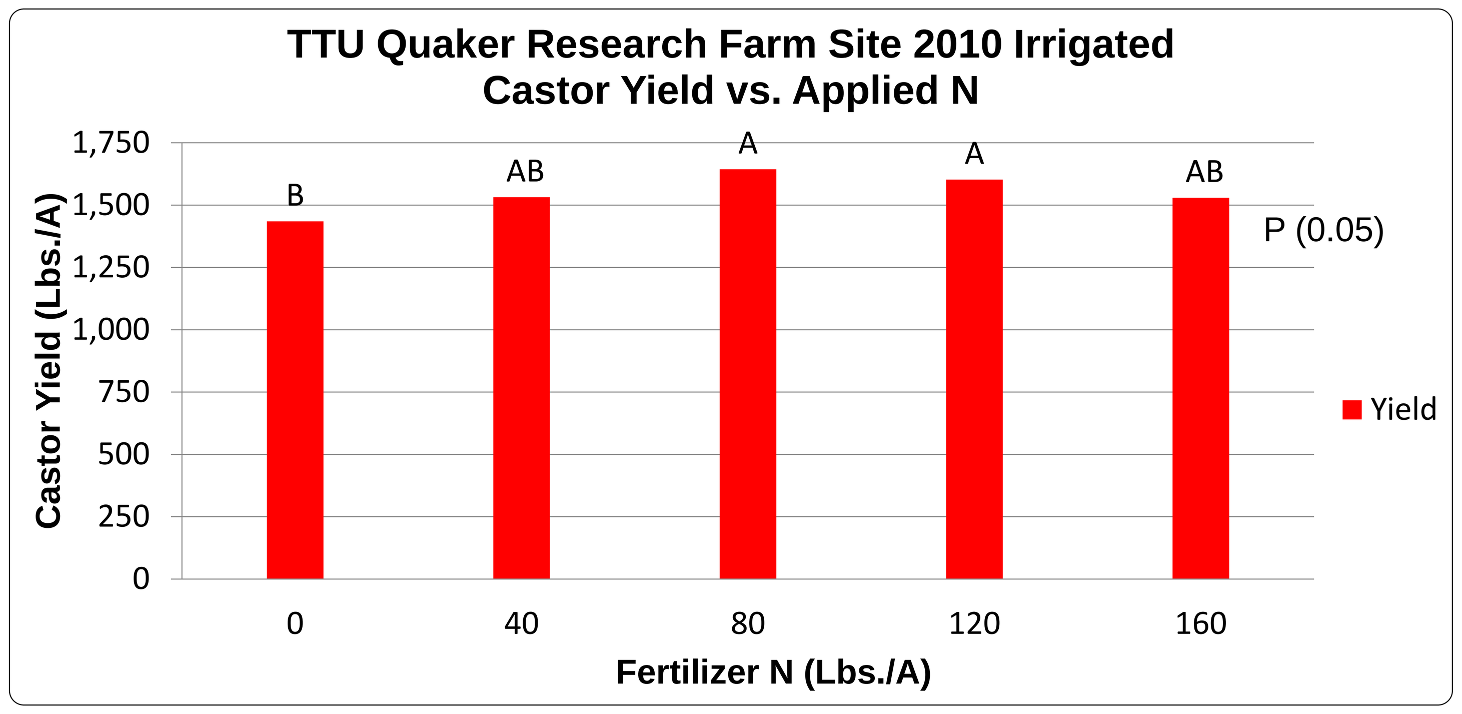


**Figure 3. Castor yield in response to fertilizer N in the presence of 44 lbs. nitrate-N/A (0-36"), Quaker Farm, 2010.**

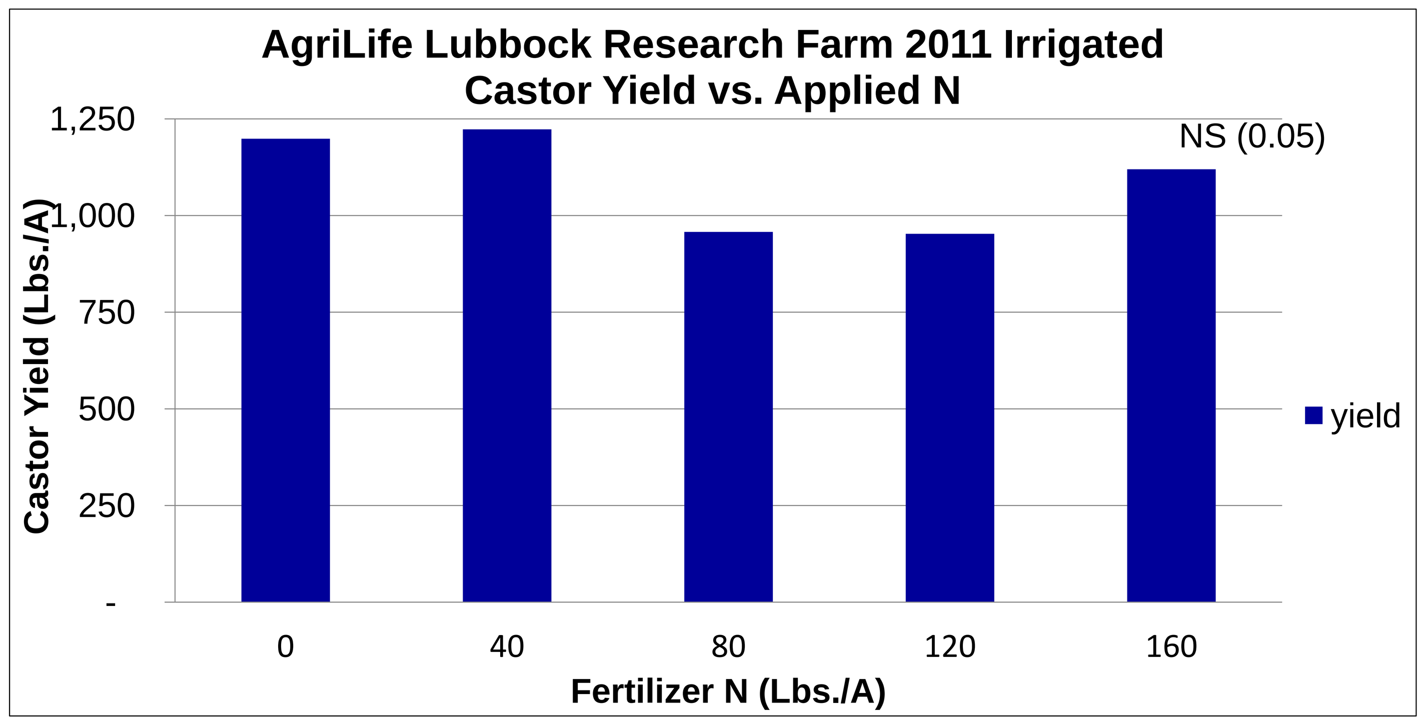


**Figure 4. Castor yield at fertilizer N levels in the presence of soil nitrate N ~295 lbs. nitrate-N/A, TX AgriLife Farm, 2011. High soil N levels preclude crop response.**

**Figure 1 A & B. Reduce-ricin semi-dwarf (3-5' tall) castor variety 'Brigham' released by Texas Tech University. Note mature racemes on plant at right.**

## CONCLUSIONS

Rainfall totals during the 2011 growing season were near zero creating conditions that were significantly different from the 2010 season in seed yield. With water being the limiting factor for several of the sites, accurate predictions of crop nitrogen needs are inconclusive based on this work. Some of the test sites demonstrate the importance of deep subsoil nitrate sampling. Four of six test sites ranged from 44 to 48 lbs. N/A in the top 36", however, only 2 of 4 sites demonstrated any significant yield response to applied N. And yield responses observed were minimal (generally less than 300 lbs./A even at 120 lbs. N/A applied).

Conclusions:

- High soil levels were found in several tests sites, most likely form over-fertilization of previous crops.
- Seed yields of up to 1,400 lbs/A are obtainable with approximately 45 lbs/A soil nitrate to the 36" depth.
- When soil N was lower, modest yield resulted from applied N for castor though the level of yield achieved may not have been economic.
- Some castor appears to benefit from applied N rates up to 80 lbs. N/A, but until further work is conducted on low-N soils, a recommendation for N application for castor production cannot be established.

## SUPPORT


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