**2010-11 California Wheat Commission Research Report**

**To:** Janice Cooper, Executive Director, Email, cooper@californiawheat.org

**Title of Research Project:** Wheat Fertilization Practices in the Imperial Valley

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**Abstract/Summary of Results and Conclusions**:
Sufficient amounts of nitrogen are needed to produce high quality wheat and economical yield in the Imperial Valley. Current nitrogen fertilization practices in the Valley may not be sufficient to produce high quality grain and maximum yield potential. Three nitrogen application rates ranging from the current N application practices (350 lb/acre) to a maximum of 550 lb/acre were implemented on small plots at the University of California Desert Research and Extension Center (UCDREC) near Holtville. The effect of preplant phosphorus rates (0, 50, and 100 lb/acre) on wheat yield and protein levels were also considered.

Yield obtained from research plots varied from 3.08 tons/ac to 4.50 tons/ac (average 3.79 tons/ac with average moisture of 7.6%). Protein levels varied from 13.61 to 15.68 (average 14.39%). In general, the rate of nitrogen fertilization in excess of 350 lb/ac did not have a significant impact on yield. However, protein content increased as the nitrogen application rate increased. At the lowest nitrogen rate, the yield increased as the P application rate increased. Results from this research will be published in the local Agricultural Briefs Newsletter and presented at the 2012 Alfalfa and Small Grains Field day in Holtville.

**Introduction and Objectives:**
Wheat was grown on more than 111,000 acres in Imperial County in 2009 (Imperial County , 2009). In 2010, the acreage dropped down to 58,562 acres but increased to about 75,000 acres in 2011 ( Imperial Irrigation District crop report 4/13/2011). The optimum planting date for the highest yields in the Imperial Valley is from early December through early to middle January. Desert Durum wheat varieties include Desert King, Orita, and Kronos. General practice for wheat grown in the Imperial Valley is to apply 300-350 pounds of actual nitrogen. Phosphate fertilizer is not commonly applied if sufficient amount of phosphorus was applied to other crops in the rotation. Less nitrogen is needed when wheat follows early winter vegetables or alfalfa. The current fertilization practices may not be applicable since wheat yields have increased from about 3.06 tons/ac in 1999 to more than 3.57 tons/ac in 2008 (Imperial County, 2009). Some of the newer varieties currently used in the Valley have the potential to yield 5 tons/acre. The objective of this research was to study the impact of different nitrogen and phosphorus application rates on wheat yield and grain protein level.

**Material and Methods:**
Three nitrogen application rates (350, 450, and 550 lbs/acre) were implemented on small wheat plots (27 plots- each split-plot 25ft*12ft) at UC Desert Research and Extension Center near Holtville. Each nitrogen rate was applied according to the standard practices in the Valley (preplant 40% of total N, tillering 30% of total N and boot stage 30% of total N). A split-plot design (table 1) was used to study the impact of pre-plant phosphorus application rates on wheat yield and grain protein levels. Three P application rates were implemented (0, 50, and 100 lbs/acre of preplant $P_2O_5$).

Table 1. Layout of split-plots at UCDREC.

| Replicate 1 | | | Replicate 2 | | | Replicate 3 | | |
|---|---|---|---|---|---|---|---|---|
| **N1** | | | **N2** | | | **N3** | | |
| P1 | P2 | P3 | P2 | P1 | P3 | P3 | P1 | P2 |
| **N2** | | | **N3** | | | **N1** | | |
| P2 | P3 | P1 | P1 | P3 | P2 | P2 | P3 | P1 |
| **N3** | | | **N1** | | | **N2** | | |
| P3 | P1 | P2 | P3 | P2 | P1 | P1 | P2 | P3 |

Nitrogen rates: N1: 350 lb/ac, N2: 450 lb/acre, N3: 550 lb/acre
$P_2O_5$ Rates: P1: 0 lb/acre, P2: 50 lb/acre, P3: 100 lb/acre

Prior to planting, composite soil samples from the top 12 inches of the soil profile were collected from each plot to determine soil salinity (electrical conductivity), P, and N levels. Pre-plant N and P fertilizers were applied to each plot according to the rates discussed earlier (40% of total N rate applied at preplanting stage). Durum wheat Variety (Desert King) was planted on December 10, 2010 at UCDREC according to the standard seeding practices in the Valley (at rate of approximately 150 lb/acre). Wheat was irrigated according to the standard irrigation practices (5 irrigations during the season based on weather factors and rainfall events). Composite soil samples were collected from each plot prior to the 2$^{nd}$ and 3rd N application events. The remaining N rates were applied during the growing season (30% at tillering and 30% at boot stage). Wheat was harvested on May 18, 2011. Wheat biomass, yield, and grain protein were determined in each plot at harvest.

Table 2. Irrigation and fertilization/fertigation events

| Date | Event | Amount applied |
|---|---|---|
| 12/10/10 | Fertilizer application and planting | 40% of N rate and 100% of P rate |
| 12/14/10 | First irrigation | 4 hr irrigation event |
| 1/20/11 | Second irrigation + water run N | 5 hr 10 min. irrigation plus 15% of N rate |
| 2/17/11 | Third irrigation + water run N | 5 hr 10 min. irrigation plus 15% of N rate |
| | Fourth irrigation + water run N | 6 hr irrigation plus 15% of N rate |
| | Fifth irrigation + water run N | 6 hr irrigation plus 15% of N rate |

Nitrogen rates: N1: 350 lb/ac, N2: 450 lb/acre, N3: 550 lb/acre
$P_2O_5$ Rates: P1: 0 lb/acre, P2: 50 lb/acre, P3: 100 lb/acre

**Results**

Average wheat yield and quality for various treatments are shown in Tables 3-5. In general, the rate of nitrogen fertilization in excess of 350 lb/ac did not have a significant impact on yield. However, protein content increased as the nitrogen application rate increased. At lowest nitrogen rate, the yield increased as the P application rate increased. But at the higher nitrogen rates of 450 and 550 lb/ac, the P application rate had no significant impact on yield.

Table 3. Average wheat yield and quality for the 350 lb/ac nitrogen rate

| P treatment | Wheat yield (ton/ac) | Protein content (%) |
|---|---|---|
| P1 | 3.68 | 14.18 |
| P2 | 3.88 | 14.15 |
| P3 | 4.20 | 14.10 |
| Average P treatments | 3.92 | 14.15 |

Table 4. Average wheat yield and quality for the 450 lb/ac nitrogen rate

| P treatment | Wheat yield (ton/ac) | Protein content (%) |
|---|---|---|
| P1 | 3.88 | 14.44 |
| P2 | 3.80 | 14.13 |
| P3 | 3.68 | 14.65 |
| Average P treatments | 3.79 | 14.41 |

Table 5. Average wheat yield and quality for the 550 lb/ac nitrogen rate

| P treatment | Wheat yield (ton/ac) | Protein content (%) |
|---|---|---|
| P1 | 3.70 | 14.43 |
| P2 | 3.79 | 14.65 |
| P3 | 3.47 | 14.72 |
| Average P treatments | 3.65 | 14.60 |

The average concentrations of N, P, and P in soil samples collected from the top 12 inches of the soil profile in each plot are shown in Appendix A.

**Discussion, Conclusions and Recommendations**

It appears that the increase in nitrogen rate did not have a significant impact on yield, however, the protein content increased with higher rates of nitrogen. At the current standard rates of 350 lb/ac of nitrogen, the addition of P fertilizer did not have a significant impact on the protein content but had a significant impact on wheat yield. The combination of higher N and P rate had significant impact on wheat quality and resulted in higher protein levels than other nitrogen treatments without P.
Additional work needs to be conducted on different soil types common for wheat production in the Imperial Valley (soil used in this study is Imperial-Glenbar silty clay loams, soil type 115). This soil is heavy clay soil with clay contents in excess of 50%. Yields obtained in this study are on the low side of the Imperial Valley average yield of

3.53 in 2009 and 3.79 ton/ac in 2010. While soil type 115, is a common ground for wheat and other field crops in Imperial Valley, the experiment needs to be conducted again on other common soil types, like soil type 110 (Holtville silty clay) which is in general better soil and the yields are typically higher than soil type 115. In addition, replicating the work on large commercial field would be useful to study the impact of various N and P rates under standard commercial practices.

**References**:

Imperial County Agricultural Crop and Livestock Report. 2009 and 2010. Agricultural commissioner's report. http://imperialcounty.net/ag/Departments/clreports.htm

Appendix A:
Soil analysis

Table 6. N-P-K in soil prior to planting on 12/10/2010

| N and P treatment | NO3-N ppm | Olsen-P ppm | X-K ppm |
|---|---|---|---|
| Avg. N1P1 | 28.21 | 19.33 | 359.00 |
| Avg. N1P2 | 30.33 | 14.70 | 369.33 |
| Avg. N1P3 | 25.95 | 15.63 | 377.33 |
| Avg N1 | 28.16 | 16.56 | 368.56 |
| | | | |
| Avg N2P1 | 25.43 | 21.53 | 361.00 |
| Avg N2P2 | 27.55 | 16.10 | 367.00 |
| Avg N2P3 | 29.11 | 21.10 | 379.33 |
| Avg N2 | 27.36 | 19.58 | 369.11 |
| | | | |
| Avg N3P1 | 28.30 | 17.23 | 354.00 |
| Avg. N3P2 | 31.56 | 14.63 | 352.67 |
| Avg. N3P3 | 25.41 | 16.80 | 358.33 |
| Avg N3 | 28.42 | 16.22 | 355.00 |

Table 7. N-P-K in soil on January 18, 2011

| N and P treatment | NO3-N ppm | Olsen-P ppm | X-K ppm |
|---|---|---|---|
| Avg. N1P1 | 41.38 | 16.70 | 371.33 |
| Avg. N1P2 | 38.10 | 22.77 | 392.33 |
| Avg. N1P3 | 31.66 | 25.73 | 371.67 |
| Avg N1 | 37.05 | 21.73 | 378.44 |
| | | | |
| Avg N2P1 | 52.51 | 14.73 | 383.33 |
| Avg N2P2 | 49.45 | 20.03 | 384.33 |
| Avg N2P3 | 48.20 | 25.33 | 394.33 |
| Avg N2 | 50.05 | 20.03 | 387.33 |
| | | | |
| Avg N3P1 | 44.03 | 16.97 | 380.33 |
| Avg. N3P2 | 47.46 | 20.67 | 392.00 |
| Avg. N3P3 | 57.56 | 28.07 | 408.67 |
| Avg N3 | 49.69 | 21.90 | 393.67 |

Table 8. N-P-K in soil on February 15, 2011

| N and P treatment | NO3-N ppm | Olsen-P ppm | X-K ppm |
|---|---|---|---|
| Avg. N1P1 | Avg. N1P1 | 15.00 | 14.83 |
| Avg. N1P2 | Avg. N1P2 | 10.31 | 21.73 |
| Avg. N1P3 | Avg. N1P3 | 10.65 | 18.63 |
| Avg N1 | Avg N1 | 11.99 | 18.40 |
| | | | |
| Avg N2P1 | Avg N2P1 | 14.86 | 13.23 |
| Avg N2P2 | Avg N2P2 | 18.65 | 12.30 |
| Avg N2P3 | Avg N2P3 | 21.10 | 34.90 |
| Avg N2 | Avg N2 | 18.20 | 20.14 |
| | | | |
| Avg N3P1 | Avg N3P1 | 18.23 | 17.20 |
| Avg. N3P2 | Avg. N3P2 | 17.08 | 19.80 |
| Avg. N3P3 | Avg. N3P3 | 21.58 | 20.70 |
| Avg N3 | Avg N3 | 18.96 | 19.23 |

Table 9. N-P-K in soil on March 18, 2011

| N and P treatment | NO3-N ppm | Olsen-P ppm | X-K ppm |
|---|---|---|---|
| Avg. N1P1 | 6.12 | 11.07 | 334.67 |
| Avg. N1P2 | 4.26 | 20.17 | 350.00 |
| Avg. N1P3 | 4.37 | 22.07 | 359.00 |
| Avg N1 | 4.91 | 17.77 | 347.89 |
| | | | |
| Avg N2P1 | 6.64 | 14.13 | 340.00 |
| Avg N2P2 | 6.77 | 17.83 | 358.67 |
| Avg N2P3 | 6.92 | 24.80 | 363.00 |
| Avg N2 | 6.78 | 18.92 | 353.89 |
| | | | |
| Avg N3P1 | 8.09 | 14.77 | 349.33 |
| Avg. N3P2 | 8.39 | 18.10 | 344.33 |
| Avg. N3P3 | 12.57 | 18.27 | 346.67 |
| Avg N3 | 9.68 | 17.04 | 346.78 |

Table 10. N-P-K in soil on April 14, 2011

| N and P treatment | NO3-N ppm | Olsen-P ppm | X-K ppm |
|---|---|---|---|
| Avg. N1P1 | 11.20 | 10.83 | 314.33 |
| Avg. N1P2 | 7.25 | 22.60 | 345.00 |
| Avg. N1P3 | 7.90 | 25.47 | 360.33 |
| Avg N1 | 8.79 | 19.63 | 339.89 |
| | | | |
| Avg N2P1 | 14.47 | 13.53 | 320.67 |
| Avg N2P2 | 17.35 | 12.47 | 328.00 |
| Avg N2P3 | 19.42 | 19.27 | 328.67 |
| Avg N2 | 17.08 | 15.09 | 325.78 |
| | | | |
| Avg N3P1 | 19.09 | 22.40 | 371.67 |
| Avg. N3P2 | 20.37 | 13.27 | 328.33 |
| Avg. N3P3 | 21.30 | 26.40 | 356.00 |
| Avg N3 | 20.25 | 20.69 | 352.00 |