Texas Corn Producers Board

Project Final Report, Dec. 19, 2014

Project Title: Estimating economic return of transgenic insect protection in corn based on yield potential, benefits from insect control, and input costs under different degrees of water availability.

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Objective and intent. Test several advanced Bt hybrids under water regimes mimicking a range of water availability relevant to Texas, in Corpus Christi, TX. The TCPB-sponsored work will be supplemented with previous Texas Coastal Bend work to obtain research-based results and economic analyses to allow dryland corn producers to better choose between transgenic hybrid options and input costs under different risks of drought, soil moisture profiles, and yield potential. First year results will help us work with TCPB to determine if additional sites and larger-scale experiments will be needed to further strengthen application of results to dryland conditions and to better apply the results to ongoing work on best water regime and hybrid choices under irrigation.

Experimental background. The test site at the Texas A&M AgriLife R&E Center, Corpus Christi was successfully established, all planned in-season measurements were taken, harvest has been completed, and data and economic analyses has been completed. As expected, the main plot water regime treatments were successful due to the late planting coinciding with low rainfall for the area. Using above ground drip, we established a non-limiting (~90+% Crop ET) water condition, a slightly to moderately limiting (~70% Crop ET) water condition, and a moderately to severely limiting (~50% Crop ET) water condition. Data on rainfall and irrigation water inputs have been processed to calculate water use efficiencies. Overall, we were near the 50% Crop ET target and under-achieved the higher 70% and 90+% targets, but a very good separation of soil moisture was achieved between the main plot treatments. Also, hybrids in a split plot were planted that were representative of best Bt technology available. Two hybrids with drought tolerance were planted. These hybrids were available along with additional financial support from companies per the original proposal intent). We were able to plant seven hybrids: two with the Leptra (Bt) gene and one without the gene with very similar background, two with the VT2P gene and one without the gene with very similar background, and two with drought tolerance (see table below).

Location: Corpus Christi
Planted: April 1, 2014; 25 ft by 4 rows, data on inner two rows, 20K seed/ac

Split plot design (4 reps):
Main plot: Non-limiting soil moisture (~90% crop ET replacement), 2 of 10 years
Moderately limiting (~70% crop ET), 5 of 10 years
Severely limiting (~50% crop ET), 3 of 10 years
Split: DK66-97: Genuity VT Double PRO (MON89 x NK603)
DK65-81*: Genuity DroughtGard + VTDoublePRO (MON89 x NK603 x MON87460)
DK66-94: Roundup Ready 2 (NK603), non-Bt
* contains drought transgene and selected under drought stress
P1401VYHR: Leptra
P1319VYHR: Leptra
P1319R: non-Bt
P1498R: AquaMax * (drought tolerance trait selected under drought stress, no Bt)

Measurements were in-season insect damage and plant height, aflatoxin (costs supported by a collaborator) and yield. Data were analyzed with ANOVA per the split plot design. The measurements for the hybrids in some cases behaved different across the water regimes; therefore the hybrids were compared separately for each water regime (Tukey's means separation test) (see details below).

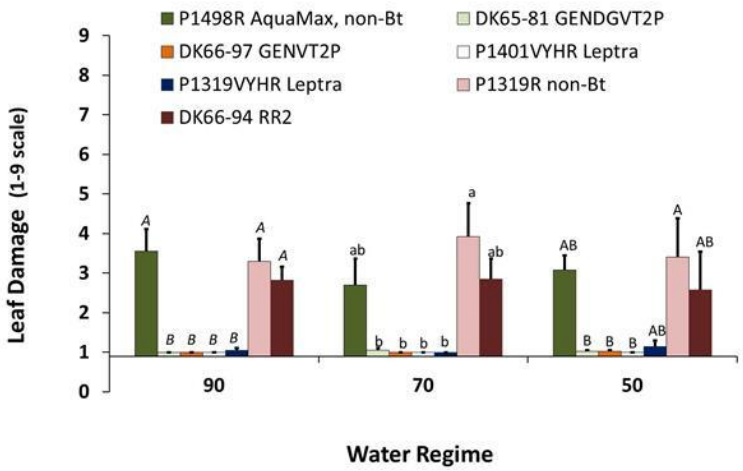
For economic analyses, the Financial And Risk Management (FARM) Assistance strategic planning model was used to evaluate the per acre economic returns of the hybrids. Scenarios simulated were based on the 7 hybrids and 3 moisture stress levels. Yield data from the field experiment were used. Seed costs were set based on estimates gleaned from current non-discounted costs (see details above).

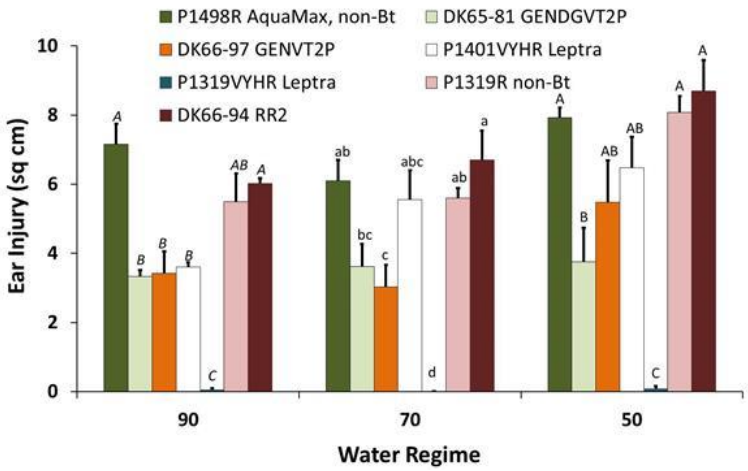
Measurements
Leaf injury (1—9 scale), almost all fall armyworm, typical for area
Ear (tip+kernel) injury (sq cm damage) mostly (>90%) fall armyworm, less typical
Plant height (cm) to top of tassel (NS, 1.9 to 2.3 m)
Yield (bu/ac) adjusted to 15% moisture
Aflatoxin (ppb), analysis on the log(ppb)
Annual return per acre (net): option $12 FAW control for non-Bt
DK66-97 at $260/bag ($65/acre), DK65-81 at $260/bag ($65/acre),
DK66-94 at $230/bag ($57.50/acre), P1401VYHR at $300/bag ($75/acre),
P1319VYHR at $300/bag ($75/acre), P1319R at $230/bag ($57.50/acre),
P1498R at $230/bag ($57.50/acre)
price $3.88/bu + $0.25 basis (feed use sales)
includes cash rent + fixed/production/opportunity cost, aflatoxin not considered

An average year market price was estimated comparing local prices to national average prices over the last five years. Based on a comparison of local to national average corn prices, the average local market price was determined to be a +$.25/bushel premium over the national average prices. This premium was added to the projected FAPRI (Food and Agricultural Policy Research Institute) national marketing year average prices for 2014-23. Average mean yields for each trial and moisture stress levels were based on actual results from the replicated trials. The base year for the 10-year analysis of the representative farm is 2014 and projections are carried through 2023. The projections for corn price trends follow projections provided by the Food and Agricultural Policy Research Institute (FAPRI, University of Missouri) with costs adjusted for inflation over the planning horizon. Net cash farm income (NCFI), one measure of profitability or net return, is the measure of used in this analysis to compare hybrids. While NCFI normally does not include non-cash items, estimated depreciation overhead costs from the Texas AgriLife Extension budget were included along with all estimated production and overhead costs.

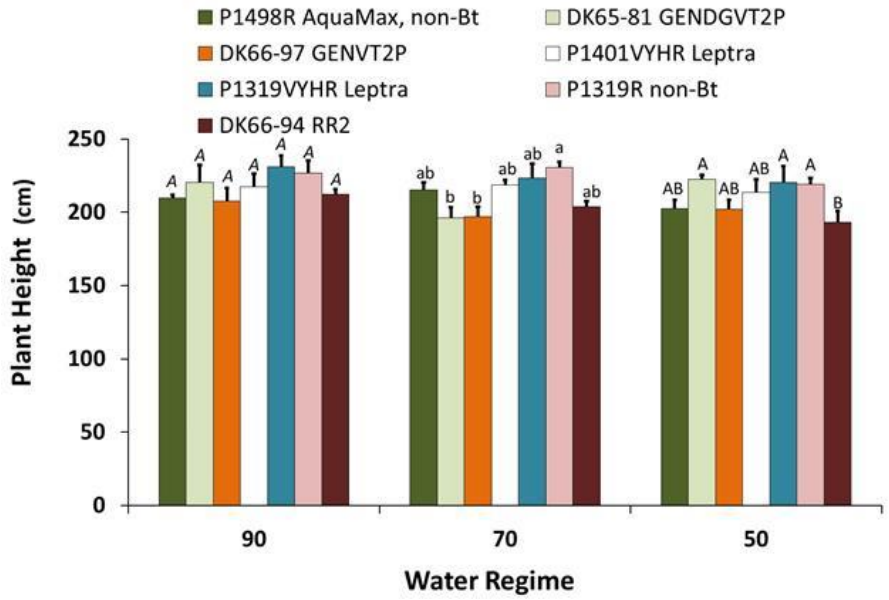
Results.

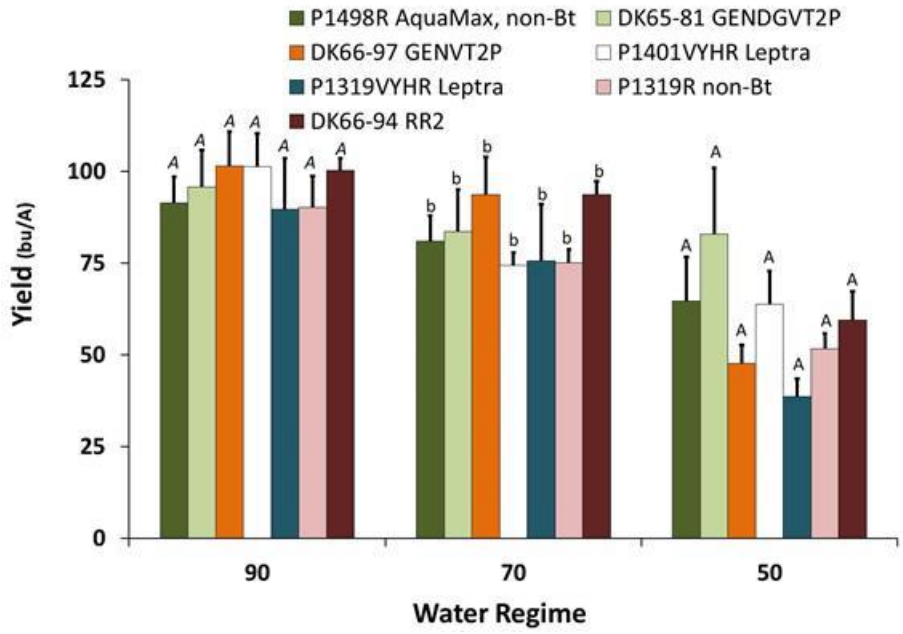
Although the fall armyworm infestation was moderate, leaf damage differences were detected among the hybrids, and leaf injury was very low for all Bt hybrids. Ear damage by corn earworm was substantial and large differences among hybrids were detected. Ear injury was low for the VT2P hybrids and one Leptra hybrid. Ear injury was exceptionally low (near zero) for the other Leptra hybrid. Leaf injury was consistent across water regimes, but ear injury increased as soil moisture was reduced generally across all hybrids except for one of the Leptra hybrids.

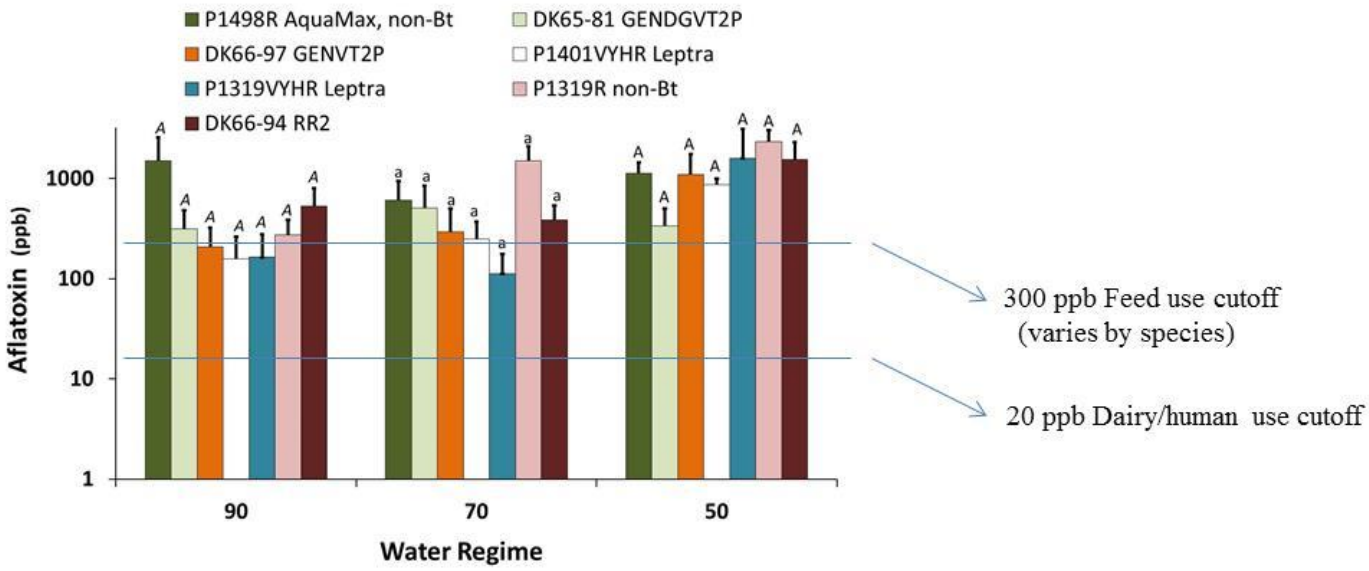




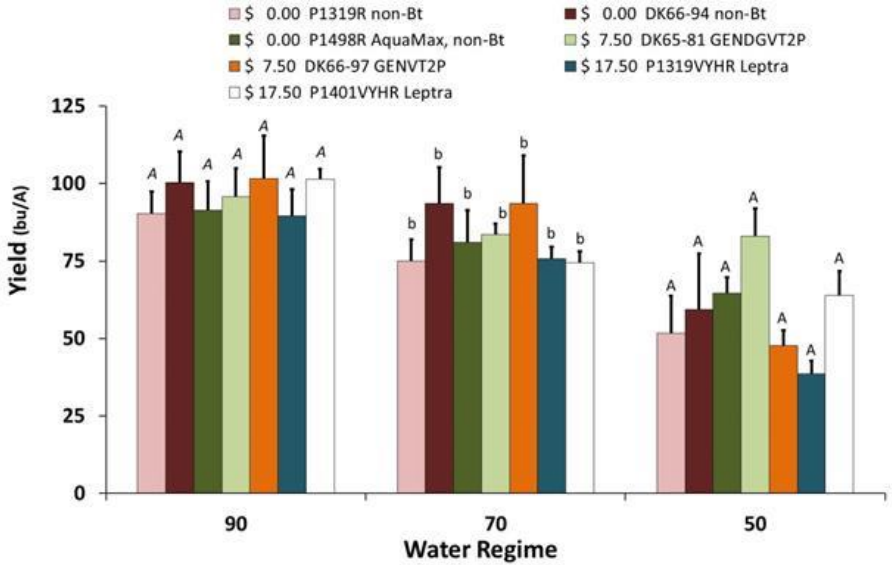
Plants were slightly shorter as soil moisture was reduced (also height to ear node, not shown). Hybrid yield varied, with no strong association of yield increase with Bt hybrids under the low leaf and modest ear injury of this test. Lower soil moisture reduced yield across all hybrids, except the drought resistant hybrid DK65-81 GENDGVT2P (light green bar) had similar yields across water regimes. The drought resistant hybrid DK65-81 GENDGVT2P (light green bar) provided a yield benefit with low ear injury and lower aflatoxin under reduced soil moisture conditions

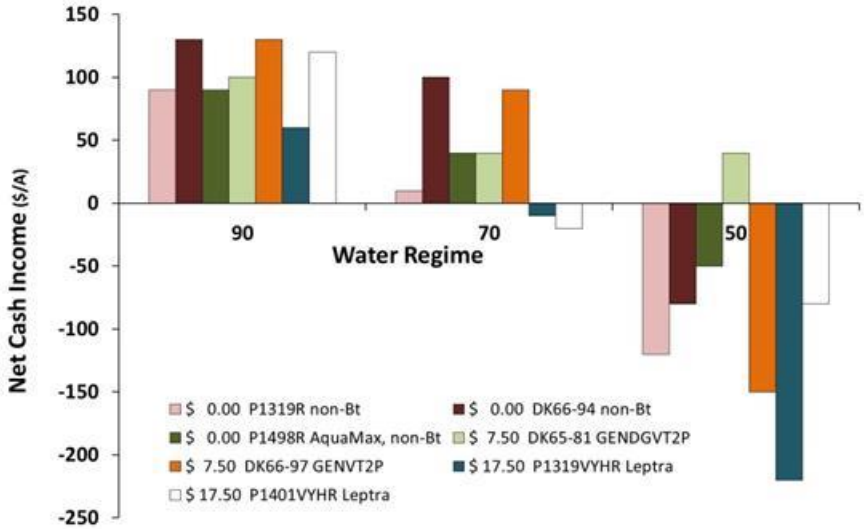






To better consider economic value of the technologies, yield and net cash income were re-assorted by the estimated additional seed cost per cost associated with the Bt and/drought tolerance traits below. The highest yields and cumulative cash flow were seen with the hybrids grown under a crop ET targeted replacement of 90%.For net cash flow, one of the high cost Leptra hybrids performed well (white bar), while the other did not (blue bar), reflecting the importance of the background genetics regardless of the excellent control of insects. Under conditions of more limiting moisture, there was more variation in yield, although statistical differences were not detected.





Of special note, the drought resistant hybrid DK65-81 GENDGVT2P (light green bar) provided a yield benefit and more stable economic return across all water regimes. One of the Leptra hybrids (white bar) but not the other (blue bar) stabilized yield under low soil moisture, but the higher cost was a drag on economic return.

Interpretation and Proposed Next Steps. Detection of differences in damage from insects across hybrids, yield variation across hybrids (but not detectable differences), and economic return analysis suggest the technology costs for insect control did not pay off under the moderate insect pressure seen in 2014**.** But there are hybrids that provided an advantage, such as the drought tolerant DK65-81 GENDGVT2P. This advantage was very important under water stress conditions, which is especially valuable to dryland corn production. The comparison of the two Leptra hybrids likely reflects the high importance of hybrid background as well. Therefore we are proposing to expand selection of hybrids in 2015 with requests in to several additional seed companies, including more drought tolerant hybrids with and without Bt transgenes. We also intend to expand the plot size to better detect yield differences. We expect more pressure in 2015 following a non-drought year, which will provide more stress associated with insect activity to complement the very good soil moisture stress we were able to experimentally manipulate.