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Field-scale Studies Evaluating the Agronomics and Economics of Selecting Double and Triple-stacked Hybrids.

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Double and triple-stacked hybrids dominate the hybrid corn industry now so we conducted field-scale studies on four farms in New York in 2007 and 2008 to evaluate the agronomics and

economics of the base genetics of a corn hybrid with double-stacked (Roundup Ready, and Bt trait for corn borer) hybrids in a corn-soybean rotation as well as triple-stacked (Roundup Ready, Bt trait for corn borer, and Bt trait for rootworm control) hybrids in continuous corn. The objective of the study was to determine if growers in New York would benefit from selecting stacked-hybrids because European corn borer is only an occasional pest in New York, western corn rootworm damage

is not as severe in New York as in the Midwest USA, and Roundup Ready resistant weeds have not been observed in New York.

As indicated in a previous What's Cropping Up? article (Vol. 19, No.3, p.3-5), a site x hybrid trait interaction for yield was observed in continuous corn but not in the corn-soybean rotation (Table 1). When average across the 2007 and 2008 growing season, the double-stacked hybrids compared with the base genetics yielded 5.7 % higher at the Jefferson Co. site and 3.6% higher (yields were rounded to the nearest bushel in Table 1) at the Onondaga Co. site in continuous corn where moderate stalk lodging occurred. In contrast, the double-stacked hybrids compared with the base genetics yielded similarly (about 0.9% lower at the Cayuga Co. and about 1.6% higher at the Livingston Co. sites) where minimal stalk lodging occurred. The results from this study indicate that the yield response to the Bt corn borer trait had significant spatial variability, which is consistent with other studies on

the use of Bt corn. The addition of the Bt rootworm trait of the triple-stacked hybrids provided no additional yield advantage compared to the double-stacked hybrids in continuous corn when averaged across sites or at individual sites. Apparently, corn rootworm did not affect corn yields in second -year corn, which corroborates the recommendations to not use a Bt rootworm resistant hybrid until third-year corn in New York (What's Cropping Up?, Vol. 18, No. 1, p.8-9).

Although there was no significant site x hybrid trait for corn yield in the corn-soybean rotation ($P=0.11$), the double-stacked hybrids yielded about 4.7 % higher compared to the base genetics at the Jefferson Co. site averaged across the 2007 and 2008 growing seasons.

Table 1. Grain yield of corn hybrids with three genetic traits at four locations in New York in continuous corn and a corn-soybean rotation, when averaged across two hybrids and the 2007 and 2008 growing seasons.

| Hybrid | Cayuga | Livingston | Jefferson | Onondaga | Mean |
|------------------------------------|-----------------|------------|----------------------------|------------|-------|
| CORN-CORN | | | | | |
| | ----- | ----- | --bu acre ⁻¹ -- | ----- | ----- |
| Base Genetics | 172 | 196 | 140 | 175 | |
| Double-Stacked^{††} | 171 | 199 | 148 | 182 | |
| Triple-Stacked[§] | 175 | 198 | 147 | 181 | |
| Contrasts | | | | | |
| Base vs. Double | NS [†] | NS | * | * | |
| Base vs. Triple | NS | NS | * | * | |
| Double vs. Triple | NS | NS | NS | NS | |
| CORN-SOYBEAN | | | | | |
| Base Genetics | 164 | 196 | 171 | 170 | 176 |
| Double-Stacked | 169 | 194 | 178 | 172 | 179 |
| Contrast | | | | | |
| Base vs. Double | NS | S | * | NS | NS |

* Significant at the 0.05 level of probability.

† NS, not significant.

†† Has the Roundup Ready and corn borer resistant genetic traits.

§ Has the Roundup Ready, corn-borer and corn rootworm resistant genetic traits.

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The yield advantage for double-stacked hybrids at the Jefferson Co. site is probably associated in part with lower stalk lodging. The double-stacked hybrids and base genetics, however, yielded similarly at the Onondaga Co. site where significant lodging differences were also observed between hybrid traits so other factors in addition to stalk lodging probably affected yield at both sites. The yield response for the double-stacked hybrids in continuous corn but not in the corn-soybean rotation at Onondaga Co. underscores the spatial variability in response to Bt hybrids for corn borer control.

When averaged across growing seasons and sites, grain moisture at harvest averaged about 1.5 percentage points greater in the double and triple-stacked hybrids compared with the base genetics, regardless of rotation (Table 2). Site x hybrid trait interactions were not observed for grain moisture in either rotation. Roundup Ready hybrids have not been reported to have higher grain moisture and the double and triple-stacked hybrids had similar grain moistures in this study. Consequently, the higher grain moisture of the stacked hybrids in this study is probably associated with the Bt trait for corn borer control, which has been observed at times in other regions of the USA and Canada. If higher grain moisture in hybrids with the Bt corn borer trait continue to occur, it could be an ongoing concern in New York for grain corn production, especially if energy prices remain high.

A site x hybrid trait interaction was observed in both rotations for partial returns (Table 3). When comparing variable costs of double-stacked hybrids vs. base genetics, the \$12/acre reduction in herbicide costs (\$18/acre for Roundup in the stacked-hybrids vs. \$30/acre for

Table 2. Grain moisture of corn hybrids at harvest with three genetic traits at four locations in New York in continuous corn and a corn-soybean rotation, when averaged across two hybrids and the 2007 and 2008 growing season.

| Hybrid | Cayuga | Livingston | Jefferson | Onondaga | Mean |
|--|-----------------|-------------|-------------|-------------|-------------|
| CORN-CORN | | | | | |
| | ----- | ----- | --%-- | ----- | ----- |
| Base Genetics | 22.9 | 21.7 | 20.3 | 28.2 | 23.2 |
| Double-Stacked ^{††} | 25.9 | 23.2 | 21.1 | 29.5 | 24.9 |
| Triple-Stacked [§] | 25.5 | 22.9 | 21.1 | 29.1 | 24.6 |
| Contrasts | | | | | |
| Base vs. Double | ** | * | * | * | ** |
| Base vs. Triple | ** | * | * | * | ** |
| Double vs. Triple | NS [†] | NS | NS | NS | NS |
| CORN-SOYBEAN | | | | | |
| Base Genetics | 24.1 | 21.2 | 21.5 | 28.8 | 22.3 |
| Double-Stacked | 26.2 | 22.7 | 22.5 | 31.2 | 23.8 |
| Contrast | | | | | |
| Base vs. Double | ** | ** | * | ** | ** |
| * Significant at the 0.05 level of probability. | | | | | |
| ** Significant at the 0.01 level of probability | | | | | |
| † NS, not significant. | | | | | |
| †† Hybrids have the glyphosate and corn borer-resistant genetic traits. | | | | | |
| § Hybrids have the glyphosate, corn-borer, and corn rootworm-resistant genetic traits. | | | | | |

preemergence herbicides in the base genetics) was mostly offset by the \$13.20/acre increase in seed costs (\$201/bag for base genetics at a seeding rate of 32,000 seeds/acre= 2.5 acres/bag or \$80.40/acre vs. \$234/bag for double-stacked hybrids or \$93.60/acre). Consequently, the main determinants of profit were increased revenue, associated with any yield advantage (average market weighted corn price in NY was \$5.05/bushel in 2007 and \$4.29 in 2008 or \$4.67/bushel), offset by increased drying costs (\$.04/point/bushel of moisture) associated with higher grain moisture. At the Jefferson Co. site, the 7 to 8 bushel/acre yield advantage resulted in increased revenue in both rotations, which was not offset by increased drying costs. Consequently the Jefferson Co. grower realized an overall profit of about \$25-35/acre for selecting double-stacked hybrids compared with the base genetics in both rotations. At the Onondaga Co. site, the 6 bushel/acre yield increase offset the increased drying costs resulting in a significant profit of about \$18/acre for selecting

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the double-stacked hybrid in continuous corn. In the corn-soybean rotation, however, the 2 bushel/acre yield increase did not offset the increased drying costs in the corn-soybean rotation resulting in no economic advantage for selecting the double-stacked hybrid. The spatial variability of the yield response between fields on the farm at Onondaga Co.

underscores the site-specificity of profitability for selecting a double-stacked hybrid in New York. Furthermore, the selection of a double-stacked hybrid compared with the base genetics resulted in a significant loss of profit at the Cayuga Co. site in continuous corn and at the Livingston Co. site in the corn-soybean rotation because increased drying costs were not offset by increased revenue from a yield increase. Growers in New York should carefully analyze expected yield increase, expected corn price for the crop, and expected drying costs before selecting hybrids with the Bt corn borer trait.

Grain moisture did not differ between the triple and

double-stacked hybrids so seed cost differences (\$248/bag = \$99.20/acre at 32,000 seeds/acre for triple-stacked) and revenue differences associated with yields were the main determinants in partial returns between these hybrid traits. The triple-stacked compared with the double-stacked hybrids had less negative partial return at the Cayuga Co. site but also less partial return than the double-stacked hybrid trait at the Jefferson Co. site. If corn rootworm has not been an historical problem in second-year corn on specific farms, the addition of the Bt corn rootworm trait to the base genetics or double-stacked hybrid could reduce profit because of the lack of yield increase coupled with increased seed costs.

Conclusion

Stacking the Bt corn borer and/or Bt rootworm traits with the Roundup Ready trait may not always be justified in New York as indicated by three of eight site-rotation comparisons

Table 3. Partial budget analyses for four farms in NY comparing the adoption of double and triple-stacked hybrids compared with the base genetics in continuous corn and adoption of a double-stacked hybrid compared with near-isolines in a corn-soybean rotation, based on additional corn grain yield and mean corn price in NY in 2007 and 2008 (\$4.67 bu⁻¹) and added variable (operating) costs at 2009 dollars for seed, grain drying, and herbicide costs.

| Hybrid | Cayuga | Livingston | Jefferson | Onondaga | Mean |
|--|--------|-----------------|----------------------------|----------|-------|
| CORN-CORN | | | | | |
| | ----- | ----- | --\$ acre ⁻¹ -- | ----- | ----- |
| Double^{††} vs. Base Genetics | -28.70 | 0.24 | 35.99 | 18.47 | |
| Triple[§] vs. Base Genetics | -11.84 | -5.06 | 21.94 | 11.85 | |
| Double vs. Triple-Stacked | -16.86 | 5.30 | 14.05 | 6.61 | |
| Contrasts | | | | | |
| Double vs. Base Genetics | ** | NS [†] | ** | * | |
| Triple vs. Base Genetics | * | NS | * | * | |
| Double vs. Triple-Stacked | * | NS | * | NS | |
| CORN-SOYBEAN | | | | | |
| Double-Stacked vs. Base | 8.68 | -19.18 | 24.76 | -8.49 | |
| Contrast | | | | | |
| Double-Stacked vs. Base | NS | * | ** | NS | |
| * Significant at the 0.05 level of probability. | | | | | |
| ** Significant at the 0.01 level of probability | | | | | |
| † NS, not significant. | | | | | |
| †† Hybrids have the glyphosate and corn borer-resistant genetic traits. | | | | | |
| § Hybrids have the glyphosate, corn-borer, and corn rootworm-resistant genetic traits. | | | | | |

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showing a profit but two site-rotation comparisons showing a profit loss. Growers who have not historically encountered corn rootworm damage in second-year corn fields should weigh the benefits of relatively inexpensive insurance against potential corn rootworm damage against increased seed costs for Bt corn with the rootworm trait. If the Bt trait for corn borer control compared with base genetics results in higher grain moisture at harvest, corn growers in New York should weigh the benefits of relatively inexpensive insurance against potential corn borer and stalk lodging problems against increased drying and seed costs, especially when energy costs are high. Other options for not incurring increased drying costs when selecting hybrids with the Bt corn borer trait is to

plant hybrids that are 3-4 d shorter in RM or to select hybrids with the same RM but to delay harvest for an additional week. Both management options would result in similar drying costs to that of the base genetics but could reduce yields because of lower yield potential associated with the use of shorter-season hybrids or increased yield loss associated with weather or pest-related problems during the extended 1-week dry-down period. The results of these studies indicate that growers in New York should carefully match each hybrid trait to their specific fields and not buy Bt stacked hybrid traits indiscriminately because of their availability or for control of potential pest problems.