Agronomic Highlight

Evaluating Corn Rootworm Risk and Economic Impact

Corn rootworms (CRWs) pose a significant threat to yield and profit, making it a pest that cannot be ignored.[1] Corn rootworm (CRW) pressure can vary widely year to year, complicating management decisions. Corn product selection is one of the most important decisions facing growers, and the seed purchase constitutes a significant expense in the crop budget.

YIELD IMPACT

A multi-year analysis of small plot university research trials proposed that yield loss is significantly correlated with the feeding level of CRWs as measured by scouting fields, evaluating roots, and assigning a root damage rating.[2] The study estimated that on average, for every node of roots pruned by CRW larvae, growers can expect an average yield loss of 15%.[2]

Rootworm damage in excess of one node of damage and in severe cases, as high as 3 nodes of damage (Figure 1 - left) is possible in the absence of corn insect traits like those found in SmartStax® technology or use of other control methods such as an at-planting soil-applied insecticide (SAI). **Using the university research as a guide, yield losses of 15-45% could be expected** under moderate to heavy infestation levels. Internal data suggest that both traits and insecticides can help protect roots from CRW feeding, with a higher consistency of performance being provided by traits through a reduction in root feeding to below economic threshold levels.

WHAT TO CONSIDER

Farmers in the Midwest should recognize the damaging potential of CRWs every planting season because CRW populations can fluctuate based on environmental conditions, soil properties, crop rotations, and management practices. A low CRW population one-year doesn't necessarily indicate that damage cannot occur the following year (Figure 1 - right).

Soil moisture can influence the survival and distribution of overwintering eggs in the soil profile. Generally, moist soils increase the potential for eggs being laid near the soil surface; however, adequate moisture is continually required to maintain survival.[3] While adequate soil moisture favors egg lay and survivability, excess soil moisture at the time of egg hatch can be detrimental to newly hatched (neonate) larvae. As an example, in Illinois, heavy spring rainfall in 2015 contributed to the death of many CRW larvae.[4]

Low soil temperatures for extended periods of time in the upper soil profile may also reduce overwintering survival.[3] Soil physical properties also contribute to the survival and growth of CRW populations. Soils that are coarse and abrasive may damage the CRW larval cuticle as they pass through the soil causing death by desiccation.[5] Muck soils have demonstrated a lower incidence of CRW larval feeding suggesting that these types of soils provide less suitable habitat for CRW.[5]

Crop rotation is a primary factor in the regulation of CRW populations, as most species of CRW normally demonstrate a high fidelity to corn fields when it comes to foraging and reproduction. In addition, northern (NCRW) and western (WCRW) larvae survive only by feeding on corn roots and a few other grassy species. As a result, crop rotation has historically been a very effective management practice in the mitigation of CRW populations. However, the extended diapause variant of the NCRW (eggs may lay dormant for one or more growing seasons) and the WCRW variant (adult beetles lose fidelity to corn fields for egg-laying) has disrupted the success of crop rotation in some areas of the Corn

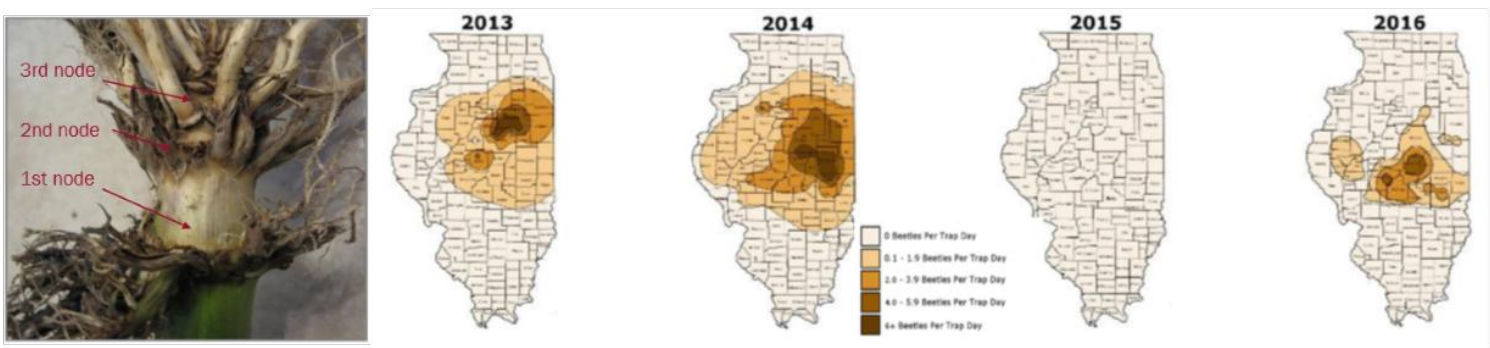

Figure 1. (Left) Root injury from corn rootworm feeding and (Right) corn rootworm beetle presence is variable and unpredictable from year to year.[6]

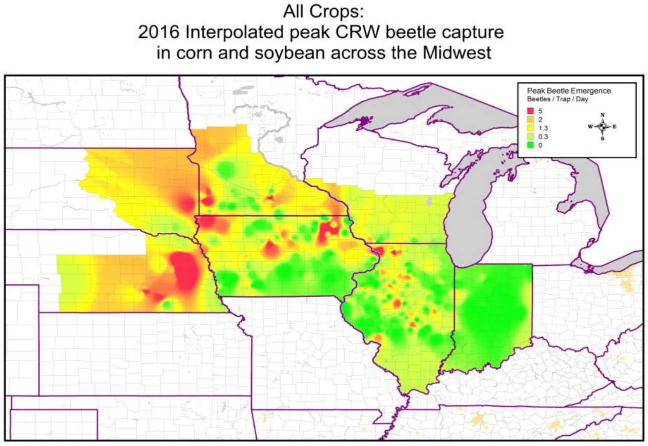

Figure 2. 2016 Monsanto Beetle Capture Results. Red areas indicate captures of greater than 5 beetles/trap/day.[5]

Corn Bushels Required to Pay for Additional Cost of *B.t. Protected Seed*											
Additional Cost ($) (Per Unit)	Corn Commodity Price ($)										
	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
10	1.6	1.5	1.3	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.8
20	3.2	2.9	2.7	2.5	2.3	2.1	2.0	1.9	1.8	1.7	1.6
30	4.8	4.4	4.0	3.7	3.4	3.2	3.0	2.8	2.7	2.5	2.4
40	6.4	5.8	5.3	4.9	4.6	4.3	4.0	3.8	3.6	3.4	3.2
50	8.0	7.3	6.7	6.2	5.7	5.3	5.0	4.7	4.4	4.2	4.0
60	9.6	8.7	8.0	7.4	6.9	6.4	6.0	5.6	5.3	5.1	4.8
70	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	5.9	5.6
80	12.8	11.6	10.7	9.8	9.1	8.5	8.0	7.5	7.1	6.7	6.4
90	14.4	13.1	12.0	11.1	10.3	9.6	9.0	8.5	8.0	7.6	7.2
100	16.0	14.5	13.3	12.3	11.4	10.7	10.0	9.4	8.9	8.4	8.0

Figure 3. The additional cost to plant B.t. protected seed.

Belt. Certain weeds such as volunteer corn, ragweed, and foxtails can also be food sources for adult CRW and support egg laying in surrounding soil.[5]

Regardless of the factors that mitigate CRW populations, population growth can occur rapidly. If corn roots are not protected, particularly in continuous corn systems, extensive CRW root feeding, damage, and root lodging may occur. The most reliable method for determining risk the following season is by monitoring CRW adult beetle activity in those fields through the latter half of the previous season. The presence and activity of adult beetles during the egg-laying period can be valuable information as the reproductive success of those insects and overwintering survival of the eggs will determine the potential infestation level the following season. Based on field surveys in 2016, there was an overall increase in CRW beetle populations across key geographies compared to the 2014-2015 seasons.[4] Areas within the Corn Growing Area had hot spots of 5 beetles/trap/day based on the information collected (Figure 2).

Regarding 2017, overwintering mortality was low due to milder temperatures, and in many areas favorable conditions early in the season promoted CRW larval survival.[6] In addition, mid- and late-season observations have suggested that populations could be at a higher level this season in areas such as Illinois, northeast Nebraska, parts of Iowa, and northeast Colorado.[7,8] In these regions, the review of industry-sponsored and independently conducted insect surveys could be valuable information to help growers determine management options in 2018.

A 2017 survey conducted by the University of Illinois, found western CRW populations to be higher compared to the same region in 2016; however, the increased population per plant is considered by the University of Illinois to be low.[7] The increase is attributed to the mild 2016-2017 winter and favorable conditions for egg hatch and adult emergence.[7] The Iowa Soybean Association On-Farm Network conducted CRW sticky trap surveys in 176 corn fields across the state during 2017 and found that CRW beetle counts were above the threshold of two beetles per trap per day.[8] The Iowa survey also reported significant numbers of NCRWs were found in corn fields that followed soybean crops in various areas across the state.[8] The highest Iowa counts were found in the driest areas because the warm, dry weather in May and June were favorable for larval hatch and survival.[8]

Despite apparent population growth in many geographies with historically high CRW activity, there are exceptions where delayed planting and wet conditions affected early season survival of CRW larvae. One example would be in large areas of Wisconsin, where University of Wisconsin reports indicate very low adult CRW beetle captures during July-August 2017.[9]

MANAGEMENT OPTIONS

To effectively manage CRW populations, growers should implement a multi-year best management practices (BMP) plan that includes 1) regular crop rotation to soybean or other non-host crops to help break the CRW life cycle, 2) the planting of dual mode of action B.t. trait products, such as SmartStax® technology, 3) the use of a SAI at planting with corn products without B.t. protection to manage CRW larvae, and 4) the use of crop scouting and thresholds for foliar-applied insecticides to reduce adult CRW population densities.
Selecting area-adapted corn products for an operation is a key for maximizing yield potential and reducing the risks associated with yearly corn production. As an example, under moderate levels of infestation, a 15% yield loss with an expected potential yield of 200 bu/acre amounts to 30 bu/acre. If the additional investment in a B.t. protected seed costs $60 per unit compared to a product without CRW B.t. protection and the price of commercial corn is $3.25/bu, 7.4 bu/acre would be needed to recoup the additional investment but with a gain of 22.6 bu/acre (30 bu/acre saved loss minus 7.4 bu/acre cost of protection) (Figure 3). Using this same scenario, CRW would only need to show up in one out of 4 years (30 bu/acre yield advantage divided by 7.4 bu/acre cost recovery) to return the investment for the extra cost of planting a CRW-traited product.
Corn growers in the Corn Growing Area should annually incorporate CRW BMPs into their operation. **The investment in CRW protection can outweigh the potential yield and profit loss** if CRWs damage the roots on a growing crop. Damaged corn roots can affect standability, nutrient uptake, and water uptake.

Sources
[1]Croff, C.D. and Mitchell, P.D. 2007. When does it pay to plant RW Bt corn in Wisconsin? Proceedings of the 2007 Wisconsin Fertilizer, Aglime & Pest Management Conference. Vol. 46. [2]Tinsley, N.A., Estes, R.E., and Gray, M.E. 2012. Validation of a nested error component model to estimate damage caused by corn rootworm larvae. Journal of Applied Entomology. DOI:10.1111/j.1439-0418.2012.01736.x. [3]Wedberg, J.L. 1996. Corn rootworms. A3328. University of Wisconsin. [4]Unglesbee, E. 2017. Rootworm outlook. Expect a rebuilding year for western corn rootworm. The Progressive Farmer. https://www.dtnpf.com/agriculture/web/ag/news/crops/article/2017/04/13/expect-rebuilding-year-western-corn. [5]Corn rootworms. 2009. Field Crops IPM. Purdue University. https://extension.entm.purdue.edu/fieldcropsipm/insects/cornrootworms.php.[6]Monsanto sampling of customer fields from internal and external sources: 305 Corn Fields (IA, IL, IN, OH, MN, NE, SD, WI) and 176 Soybean Fields (IA, IL, IN, OH, WI). [7]Estes, K. 2017. Increased insect densities reflected in annual corn and soybean survey. The Bulletin. University of Illinois. http://bulletin.ipm.illinois.edu/?p=3956. [8]Arp, A. 2017. Beetle counts high across Iowa. ISA Newsroom. http://www.iasoybeans.com/news/articles/beetle-counts-highacross-iowa/. [9]Corn. Corn rootworm. Wisconsin Pest Bulletin. 2017. Volume 62. No. 17. 8/24/17. Additional source: Hodgson, E. and Gassmann, A. 2015. Corn rootworm management update. Integrated Crop Management. Iowa State University. https://crops.extension.iastate.edu/cropnews/2015/08/cornrootworm-management-update. 170929071801
