Minutes from the November 21st 2011 Bt-corn Technical Committee Meeting 12/6/11

Notes from the BPC Technical Advisory Committee

The Bacillus thuringiensis genetically modified corn (Bt-corn) technical committee of the Maine Board of Pesticides Control (BPC) met on November 21st from1:00 to 4:00 pm at the Pest Management Office at the University of Maine.

Members present were: Tom Cote, Lauchlin Titus, Jim Dill, Eric Sideman, Andrei Alyokhin; John Jemison chaired the meeting. Lebelle Hicks was present as staff to the committee and guests included Lindsey Flexner from Pioneer Hi-Bred International and Derek Hines, sales staff at Pioneer.

The issue at hand is the pending registration of two Pioneer Dupont products with seed blended (refuge in a bag (RIB)) at reduced refuge requirements. Specifically the products under consideration are: Optimum AcreMax (EPA# 29964-12) with 5% RIB and Optimum AcreMax Xtra Insect Protection (EPA# 29964-11) with 10% RIB. Optimum AcreMax is active against lepidopteran pests and Optimum AcreMax Xtra is active against lepidopteran and corn root worm pests. The specific events and Bt proteins expressed in these two products are currently registered in other Bt-corn products.

The group began our discussion with some questions raised by Henry Jennings, BPC staff director. The first three questions were approached as a group and were focused around the possibilities of resistance from foliar Bt and resistance from Plant Incorporated Protectants (PIP) Bt:

1. How likely is it that resistance would develop independently to foliar applied Bt versus Bt contained in PIPs?

2. Are the proteins being used in the PIP products the same as the one(s) found in foliar applied Bt? Especially the foliar products used on sweet corn

3. If resistance developed to Bt corn, how would it affect the foliar applied products? Would it be specific to the individual proteins contained in the various technologies/products? I gather it would be specific to the pest species that develops resistance.

We discussed that Bt applied in a topical manner is a mixture of many different proteins that may have a variety of mechanisms to lead to death of specific organisms. There are many toxic crystalline “cry” proteins, vegetative insecticidal proteins “VIP” and other substances that are toxic to the lepidopteron insects, coleopteran and related insects. The effectiveness of topically applied materials is quite good, but their longevity is less due to breakdown. It is generally assumed that Bt cry proteins in PIPs are more effective because of the high dose. However, since they are constantly present, the potential for resistance is higher especially with reduced refuge where only one protein is expressed by the plant. The real question with this issue is the mechanism of the resistance. If the

insect can correct or heal, (general, non-specific resistance) after feeding, then both foliar and PIP Bt formulations could become less effective if the PIP formulation led to resistance. If the PIP resistance is a change in a specific receptor (specific resistance), it may not affect resistance in other organisms.

4. If insect resistance developed in other states where this technology is currently used, would resistant insects migrate to Maine anyway? This probably differs by insect, so it would be good to know the answer by insect, especially for those insects that might attach organic sweet corn ears.

This was a really important question because we know that Corn Ear Worm (CEW) and Fall Army Worm (FAW) do not overwinter in Maine. In Jim's opinion, black cutworm can overwinter in some years. This represents two or three of the five main insect pests that PIPs control. If resistance develops in another state, the resistant insects will blow into Maine on a storm front, lay their eggs, and the PIP technology will fail. But it won't be caused by our practices. Western corn rootworm (which is a beetle) does not travel widely – its spread in the state has been limited to mostly southern and western Maine. It can fly, but it doesn't usually travel widely. It does overwinter in Maine, and so it is possible that if resistance develops, it would cause an issue, but it's less of a concern today. We also discussed that during Tropical Storm Irene, much corn was affected by high winds, but not much actually was uprooted showing further that we do not have much rootworm problem in Maine. The last insect of issue is European Corn Borer (ECB). We discussed that this is the insect for which resistance could be important. It overwinters in the stalks (that is why the sweet corn refuge for this pest is to disk or mow the stalks after harvest). We discussed that only 10 – 15 percent of the corn is grown for grain, so some of the insects that could survive would be chopped with the silage. Some could remain in the cut corn stumps in the field, particularly depending on the cutting height. The other issue is that by reducing from a 20% to a 5% refuge with a stacked or pyramided corn hybrid, the number of ECB surviving will be smaller, which may reduce the numbers to a point that they have become sufficiently altered that they may not be ecologically fit to reproduce and continue in a healthy manner.

5. How will we know if insect resistance develops in Maine? This sounds especially difficult with refuge in the bag.

The standard practice if a particular area starts to lose effectiveness with a specific PIP is that industry will come in, collect insects, and try to do dose response to confirm a control failure. This would be done here if we felt there was failure. One of the strengths of the 5% refuge in the bag (RIB) is that it is much simpler to plant, less to track for record purposes, and is cheaper for growers in terms of fuel usage, time, etc. But a drawback of RIB is that a grower has less chance to see if the technology was useful to him/her in that year. Some growers are good at scouting and want to know if the technology has paid

for itself, while others are simply happy their corn "insurance" plan is in place and they can think about other things. So if the technology fails, it will likely be more difficult to tell unless growers see it at harvest.

Questions 6, 7 and 8 were also considered together.

6. If resistance were detected in Maine, could it be effectively mitigated or managed? This question would be especially important for the insects that would attach corn ears.
7. Are there effective alternatives to foliar Bt for organic sweet corn growers?
8. Does resistance development in one species indicate a greater likelihood of development in other species?

These are discussed together because part of 6 was addressed above. The alternative to Bt for sweet corn growers is spinosad or the product Entrust. It is effective but expensive. If insects become resistant to it, then resistance to both would mean wormy sweet corn for organic markets which may or may not be an issue. The last question of this set is interesting and less clear. Again it in part goes back to the discussion around question 1. Most organic growers use Bt on brassicas because there is less tolerance about insect damage/presence with brassicas. The insects that feed on brassicas are diamond back moth, cabbage looper moth, imported cabbage moth, among others. Bt resistance to ECB, CEW, FAW would likely not affect these insects.

9. If resistance develops to the Bt proteins used in the PIP technology, where does that leave conventional growers? Are there new Bt proteins in development? Is the Bt line of PIPs a dead end once resistance develops?

As we discussed this issue, there was talk about new product development, new materials being important, but that stewardship of the products we have is very important. The research scientist from Pioneer Dupont, Lindsey Flexner, expressed that stewardship is very important and that they believe that pyramided or stacked lines will ensure that there is not resistance at least as well or better than a refuge that may or may not be followed by growers. The southern MN rootworm failure was largely caused by compliance failure to plant the refuge. Southern grower compliance was said to be considerably less (around 35%). With RIB, a grower can't cheat and not plant the refuge. But the considerable expense involved in developing these technologies would not favor pushing to get a reduced refuge if they thought it would fail in 10 years.

John Jemison came to the discussion with a few specific questions. 1) Was the pest, Pink Bollworm, of cotton actually recessive with respect to the alleles present in traited cotton. If so, doesn't it fail to meet the concept of high dose/refuge being an effective methodology – Lindsey said indeed the pink bollworm did appear to fail to transfer the gene to the offspring in a recessive manner likely leading to its early/premature failure.

2) How long will it be before only traited corn sold would be refuge in bag? One would think that the "values" brought by the RIB would mean that the others should be phased out?

Lindsey agreed that this would likely be a logical end product of this. Because of Maine's short growing season, it is arguable that the highest end genetics are not going into such short corn lines anyway. So, if we approve of this or not, we are not likely keeping our growers from having access to the best genetics, but in time, the single trait hybrids will likely be phased out and only these will be available to growers.

3) John also asked how many times had pest populations (particularly black cutworm) overwhelmed the corn's capacity to survive. It seems this has happened twice. Interestingly, Cry 1F, which is active on black cutworm, acts more like an antifeedant than a toxic insecticide. They can't get an LC-50 for this protein. It begs the question as to whether stacking Cry1F and Cry1Ac with or without rootworm genetics (cry 34/35) is actually an effective pyramid. We agreed that the strength of the pyramid / stacked protein is only as good as the effectiveness of the parts. John continues to pursue this question.

After this point, Lindsey and Derek left the meeting, and we had some final discussion. In the end a reduced refuge planting program likely increases the risk of resistance. Resistance happens eventually to all insecticides. The question is how much difference will it make for us. As discussed previously, many affected insects don't overwinter in Maine. Black cutworm may overwinter in some years. Only one or two of the five pests would be affected by reduced refuge at this time: ECB and BCW. Given the damage ECB has caused some potato stands, the possibility of reducing ECB numbers could possibly be as helpful to the potato industry as the dairy industry if ECB numbers were really reduced with widespread use of Bt corn. This is uncertain.

Ultimately all models are based on assumptions, and their accuracy is based in part on those assumptions. The models say the pyramided hybrids will do a better job to prevent resistance than the 20% refuge system, assuming it is employed. It is very likely that RIB will be more effective than growers who ignore the refuge. Apparently fewer growers are adhering to the refugia practice today in Maine than when licensed growers were checked a few years ago.

John expressed that he is personally pleased that Pioneer will respect the current rule for implementing a block refuge for organic growers to protect from pollen drift. This may or may not be followed with other corn hybrid producers.

Andrei summarized his position as follows:

In my opinion, reducing refuges for Bt corn to 5% and switching from a structured to a blended refuge increases the risk of resistance development by insect pests. However, in Maine pest pressure is relatively low, with several pest species not even overwintering here. Also, sizes of natural refuges are relatively high compared to that of Bt corn fields. Furthermore, cutting corn early for silage is likely to further reduce the numbers of resistant insects. Weighing these factors against economic issues involved in maintaining a 20% structured refuge, I believe that 5% blended refuge for pyramided Bt corn is an acceptable approach in the state of Maine. I would be reluctant to make a similar recommendation in major corn-growing states until more scientific data on refuge performance is collected, but we do not have jurisdiction over those. As far as Maine is concerned, I do not envision Bt resistance being much of an issue.

Eric's position is as follows:

Bt is perhaps the single most important tool to organic growers for insect management. It is most important for brassicas, but some growers use Bt to manage the ECB in corn, peppers and potatoes. The repercussions of ECB or other insects developing resistance to Bt is more severe for these organic growers than conventional growers because organic growers have fewer chemical tools for insect management, and tools are developed less frequently. This is simply because the organic market is smaller and pesticide manufacturers often decide that the market is too small to justify the expense of development. Consequently, if Bt efficacy is reduced because of development of resistance, organic growers will suffer greatly with little chance of an alternative being introduced to the market.

The RIB proposal does offer a grower friendly alternative to a 20% block refuge, and a technology that may offer the same level of management of resistance development. But that word "may" is troubling. There is little clear scientific evidence whether implementing the proposed stacking and RIB would or would not accelerate resistance, other than reports from the manufacture. There is no evidence that 5% is a large enough refuge. If I were a conventional grower, I may take the risk and hope that it is, and if resistance did develop I would be confident that a new technology would be offered to replace the failure of Bt. But I have no such confidence as an organic grower.

The fact that grower compliance with refugia is low and that RIB may work better than the low compliance does not justify the proposed dramatic refuge reduction. The low compliance does justify a greater effort by the BPC to enforce compliance. I believe that the 20% block refuge can do a good job of reducing resistance build up. I do not believe that the RIB and reduced refuge should be

permitted until additional independent studies are available that provide a clearer scientific foundation.

John's opinion: We have conducted and published peer reviewed research showing that the PIP technology leads to less insect activity when grown in Maine, but it did not lead to improved forage yield, quality or lower forage mycotoxin levels. Data from those trials and 20 years of conducting other research in Maine lead me to argue that environmental conditions influence yield and forage quality more than corn genetics. In my role as an agronomist, I have taken this message out to growers, but many are convinced that this technology is necessary on their farms.

The board puts great value on technologies and approaches that use integrated pest management approaches. I question whether an approach that makes a grower have to decide he or she has a pest problem long before the season begins meets my definition of an IPM approach to pest management. But, that does not reflect the opinion of the committee as a whole. The 20% refugia approach approved by EPA was a fairly difficult and time-consuming requirement for growers, and I understand their dislike for it. But, it allowed growers to test the effectiveness of the technology in the field where it was planted, particularly if planted in a block pattern. The seed companies have not done their diligence to ensure growers are complying with the refugia, and I don't think the board has the staff to follow up with all growers using the technology.

Overall, the board's role is not to determine for growers what they should or shouldn't grow, it is to determine if this technology puts other producers, consumers, or the environment at a greater risk than the benefits it might bring them. So, while I too think the RIB approach could lead to faster resistance and potentially reduce the effectiveness of organic grower's topically applied Bt insecticides, there is no data to prove this conclusively. I find myself forced to rely on Andrei's rationale, and I will hope that the models are correct and it does not lead to increased likelihood of resistance.

In conclusion, the Board must decide whether to approve RIB corn. Given the known failures where refugia has not been employed (Southern Minnesota failure), uncertainty of cross resistance, and potential utility that it brings to growers, most of the technical advisory team recognizes that adopting RIB corn may increase the likelihood of resistance, but that risk may be balanced out by insurance of compliance. From Eric's comments, the Board will recognize that not all members support the approval, but on balance the majority of the technical committee is supportive of approval.