**BIOPESTICIDES REGISTRATION ACTION DOCUMENT**

# *Optimum® AcreMax™ B.t. Corn Seed Blends*

**U.S. Environmental Protection Agency (EPA)**
**Office of Pesticide Programs**
**Biopesticides and Pollution Prevention Division (BPPD)**

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# I. OVERVIEW

## A. BACKGROUND

On April 30, 2010, EPA conditionally registered the plant-incorporated protectant products, Optimum® AcreMax™ 1 (OAM1), a seed blend of 90% HERCULEX® XTRA and 10% HERCULEX® I, and OAM RW, a seed blend of 90% HERCULEX® RW and 10% Non-*B.t.* Corn. These registrations were set to expire on September 30, 2010. The Agency determined that the use of these pesticide products is in the public interest and that their use during the limited time of the registration would not cause any unreasonable adverse effects on the environment. The registrant for both products is Pioneer Hi-Bred International, Inc. (Pioneer). OAM1 is the first registered B.t. corn product to incorporate a "blended" refuge; i.e., the OAM1 product requires a 10% refuge for corn rootworm, and the corn rootworm refuge seed is sold within the same seed bag as the B.t. corn rootworm product. (OAM1 also requires a separate 20% refuge for lepidopteran pests, and that refuge is in the form of a structured refuge that is sold separately).

On October 1, 2009, EPA announced a new policy to provide a more meaningful opportunity for the public to participate on major registration decisions before they occur. According to this new policy, EPA intends to provide a public comment period prior to making a registration decision for, at minimum, the following types of applications: new active ingredients; first food uses; first outdoor uses; first residential uses; and other actions for which the Agency anticipates that there will be significant public interest.

Consistent with the policy of making registration actions more transparent, the proposed amendments to the expiring OAM1 and OAM RW corn products were subject to a 30-day comment period because the Agency believes, given past experiences with PIPs in general, these actions are of significant public interest. Based on all data submitted in support of the expiring OAM1 and OAM RW corn registrations and in consideration of the public comments received, the Agency concluded that it is in the best interest of the public and the environment to amend the currently existing OAM1 and OAM RW registrations by extending the current expiration dates to September 30, 2012. The basis for this decision can be found in the risk assessments for the expiring OAM1 and OAM RW, and our responses to comments on the original OAM1 and OAM RW registrations, all of which are set forth in this Biopesticides Registration Action Document (BRAD).

In addition to the expiring OAM1 and OAM RW corn products, there are other *Bt* corn PIPs, expressing different proteins effective in controlling various lepidopteran and coleopteran pests, that were set to expire in 2010, and for which the associated registrants have formally requested an extension to the current expiration dates. Therefore, within the same docket (EPA-HQ-OPP-2010-0607) as this document, the following information were also available for public examination:

- Cry1F and Cry1Ab BRAD
- Cry 3Bb1 BRAD
- Cry34/35Ab1 BRAD
- mCry3A BRAD
- Optimum® AcreMax™ *B.t.* Seed Blends BRAD
- Current Registration Terms and Conditions for *Bt* Corn Registrations Set to Expire in

2010
- Proposed Registration Terms and Conditions for *Bt* Corn Registrations Set to Expire in 2010

EPA made the decision to amend the registrations of eighteen (18) expiring *Bt* corn PIP registrations to extend the expiration dates. We conducted comprehensive assessments of each of these registrations, considering all toxicity and environmental effects data, data from insect resistance monitoring, and insect resistance refuge compliance reports, received and obtained since the last comprehensive evaluation of these products in 2001. Based upon our comprehensive assessment, we reached significant conclusions regarding the positive environmental impact of *Bt* corn PIPs, and we took several actions to strengthen the insect resistance management requirements to ensure continued success in the prevention of the evolution of resistance in target pests.

Since the commercialization of *Bt* crops, there have been a significant number of published field studies that, combined with the post-registration field studies required to be submitted to the Agency, have demonstrated that non-target invertebrates are generally more abundant in *Bt* cotton and *Bt* corn fields than in non-transgenic fields managed with chemical insecticides. Thus, these published and registrant-produced studies demonstrate that, not only are the *Bt* crops not causing any unreasonable adverse effects in the environment, but, arthropod prevalence and diversity is greater in *Bt* crop fields.

To strengthen insect resistance management of these corn PIPs and to address reports that compliance with the mandated refuge requirements has been decreasing, EPA is requiring enhanced compliance assurance programs (CAPs), and a phased requirement for seed bag labeling that clearly shows the refuge requirements. Also, given the increasing variety of PIP products and combinations, and the differing risk of resistance evolution that the various products represent, we are granting registrations for the corn PIP products for different time frames, based on assessments of their likelihood of forestalling the evolution of insect resistance. We are registering differing categories of products for differing time periods to reflect the assessed level of risk of resistance posed by the various corn PIP products. The scheme that we are following includes registration periods generally of five, eight, and twelve years; with the possibility of a fifteen-year registration period for products that are demonstrated to meet specified criteria. We retain, however, the discretion to register products for time periods differing from these defaults where circumstances warrant. In the case of OAM1 and OAM RW, we have extended the registrations for two years.

## B. USE PROFILE

### Active Ingredients:

*Bacillus thuringiensis* Cry34Ab1 and Cry35Ab1 proteins and the genetic material necessary for their production (PHP17662 T-DNA) in event DAS-59122-7 corn (OECD Unique Identifier: DAS-59122-7)

*Bacillus thuringiensis* Cry1F protein and the genetic material (plasmid insert PHI8999A) necessary for its production in corn event DAS-Ø15Ø7-1

## Trade & Other Names:

HERCULEX® I => Cry1F Corn

HERCULEX® RW (Rootworm) => Cry34/35Ab1 Corn

HERCULEX® XTRA => Cry1F + Cry34/35Ab1 Corn

Optimum® AcreMax™ 1 (OAM1) => Seed Blend of 90% HERCULEX® XTRA and 10% HERCULEX® I

OAM RW => Seed Blend of 90% HERCULEX® RW and 10% Non-*B.t.* Corn

**OPP Chemical Codes:** 006490 (Cry34/35Ab1 corn) and 006481 (Cry 1F corn)

**Type of Pesticide:** Plant-Incorporated Protectants (PIPs)

## Product Profile:

*HERCULEX® I*
The registration for Cry1F Event TC1507 (Event DAS-01507-1), also known as HERCULEX® I, was first granted by the Agency on May 18, 2001. HERCULEX® I expresses the Cry1F insecticidal crystal protein as well as the PAT (phosphinothrin acetyl transferase) protein, which confers tolerance to the herbicidal active ingredient glufosinate-ammonium. Cry1F is efficacious against lepidopteran pests, and the primary target pest of HERCULEX® I is the European corn borer (ECB, *Ostrinia nubilalis*); other target pests are corn earworm (CEW, *Helicoverpa zea*), southwestern cornborer (SWCB, *Diatrea grandiosella*), fall armyworm (FAW, *Spodoptera frugiperda*), western bean cutworm (WBCW, *Richia albicosta*), and black cutworm (BCW, *Agrotis ipsilon*). The main target pests for which insect resistance management (IRM) requirements apply are ECB, CEW, and SWCB.

*HERCULEX® RW*
The registration for Event DAS-59122-7, also known as HERCULEX® RW, was granted by the Agency in August, 2005. HERCULEX® RW expresses *B.t.* toxins Cry34Ab1 and Cry35Ab1, which are efficacious against coleopteran pests. The primary target pests of HERCULEX® RW are western corn rootworm and northern corn rootworm (CRW, *Diabrotica* species). Maize containing Event 59122-7 has been modified to express the PAT protein, which confers tolerance to gluphosinate-aluminum herbicide.

*HERCULEX® XTRA*
The registration for HERCULEX® XTRA (Event TC1507 x DAS59122-7) was granted in October 2005. HERCULEX® XTRA is the result of a conventional breeding cross between HERCULEX® I and HERCULEX® RW and is considered a stacked PIP because it targets two different kinds of pests (Lepidoptera and Coleoptera) and contains two separate PIP active ingredients.

*OAM1: EPA File Symbol 29964-6*
In February, 2008, Pioneer Hi-Bred International, Inc. submitted an application to register Optimum® AcreMax™ 1 Insect Protection, a new blended seed product that contains two

different kinds of seeds of the already registered products HERCULEX® XTRA and HERCULEX® I. The new product incorporates the CRW refuge into the seed bag. The seed blend percentage was amended to 90% HERCULEX® XTRA and 10% HERCULEX® I.

*OAM RW: EPA File Symbol 29964-10*
In November 2009, Pioneer Hi-Bred International, Inc. submitted an application to register Optimum® AcreMax™ RW Insect Protection, a seed blend consisting of 90% HERCULEX® RW and 10% non-*B.t.* Corn. The new product incorporates the CRW refuge into the seed bag and also can serve as a refuge for the Cry1F portion of OAM1.

## Pioneer's Projected Use in 2010, 2011, and 2012

Pioneer's forecast for OAM1 U.S. acreage in the 2010, 2011, and 2012 growing seasons is listed below. Pioneer states that "[t]hese estimates have been divided into high-pressure areas for corn rootworm (i.e., the Red Zone) and non-Red Zone acres (i.e., the remaining U.S. corn acreage outside the Red Zone). The Red Zone is defined by Pioneer as 90 counties that have a 100% chance of corn rootworm infestation in any given year. These counties are primarily located in northeastern Illinois, northwestern Indiana and, to a lesser extent, southeastern Wisconsin and southwestern Michigan. Because of the strong selection pressure present in the Red Zone, it is considered a potential area for corn rootworm resistance to develop. The percentages are based on general USDA acreage projections, which project a total of 90 million corn acres in the U.S. in 2010, 2011, and 2012."

| Growing season | Red Zone geography | Non-Red Zone geography |
|---|---|---|
| 2010 | ~0.077% | ~0.042% |
| 2011 | ~5.8% | ~8.2% |
| 2012 | ~8% | ~12% |

Pioneer provided information to EPA indicating that the total OAM1 acres planted in 2010 was 34,804, which is less than originally projected. (Rood 2010). Pioneer has not changed the initial projections for 2011 and 2012.

# II. INSECT RESISTANCE MANAGEMENT

## FIFRA Scientific Advisory Panel (SAP)

Pioneer/Dupont's initial registration application for OAM1 consisted of a seed blend of 95% HERCULEX® XTRA and 5% [3.5% (±1.5)] HERCULEX® I. The HERCULEX® I was intended to serve as the IRM refuge for the corn rootworm active component of HERCULEX® XTRA. The proposed seed blend strategy and reduction in refuge from 20% to 2% to 5% represented a significant paradigm shift for the *B.t.* IRM strategy that has been employed for over 15 years. BPPD conducted a risk assessment and presented preliminary conclusions to the Scientific Advisory Panel for peer review on February 23 to 24, 2009.

The SAP (2009) expressed concern about the proposed refuge reduction. The Panel concluded that there was no compelling evidence, either in the data provided by Pioneer or in the public literature, to support a 5% blended refuge for this particular product. The Panel noted, however, that the biology of the corn rootworm makes it susceptible to successful control and mitigation by a seed blend methodology, if the refuge is of sufficient size.

Ad hoc members of the SAP commented on EPA's grant of the OAM1 registration for 2010. These members noted that the 2009 SAP had voiced concerns on the simultaneous approval of a blended and reduced refuge for corn rootworm, and stated that EPA "ignored" the 2009 SAP's general conclusion to retain a 20% refuge while research continues. In granting a registration for sale and distribution of OAM1 for the 2010 growing season, EPA did consider and rely upon the advice of the SAP. Pioneer's initial application sought approval for a 2.5 % blended refuge and that is what EPA took before the SAP. Concerns raised by the SAP were a major factor in why the Agency did not approve the 2.5% blended refuge proposal. Moreover, the concerns raised by the SAP, and other commenters, are a significant factor in certain of the unique terms and conditions that EPA is placing on the OAM1 registration for 2011 – 2012. The ad hoc members also commented that the SAP's concerns regarding Pioneer's hypothesis concerning mode of action were not addressed. EPA did not specifically address the SAP's recommendation on the mode of action hypothesis because that hypothesis did not play a role in our decision. EPA similarly has concerns as to the validity of the mode of action hypothesis and did not in any way factor this hypothesis in our decision.

## Current Submissions

OAM1 is a blended seed product that contains 90% HERCULEX® XTRA seeds (Cry34/35Ab1 x Cry1F) and 10% HERCULEX® I seeds (Cry1F).

OAM RW is a blended seed product that contains 90% HERCULEX® RW seeds (Cry34/35Ab1) and 10% non-*B.t.* Corn.

## Seed Blending

Pioneer submitted information and analyses supporting their claim that refuge plants will be randomly distributed throughout the field, including information indicating that the expected error of mixing the refuge seed is ±1.5% (using the seed mixing technology described in their submission) and that the standard deviation for planting the correct percentage of refuge is ±1%.

## IRM Modeling

### EPA Model Description

EPA'S POPGEN (Population Genetics) simulation models are a series of generalized, flexible population genetics modeling systems modeling the evolution of resistance to conventional pesticides and transgenic crops. The programs are capable of simulating complex landscapes that vary spatially as well as temporally over the course of a growing season.

POPGEN-D

The deterministic model POPGEN-D is a relatively simple frequency-based model that incorporates non-compliance estimates, non-random mating in refuge fields, and larval movement. The model permits modeling of both block refuges and blended seed-mixture refuges.

POPGEN-S2

The stochastic model POPGEN-S2 is a modification of an earlier stochastic, spatially explicit, dual locus, simulation model designed to evaluate the development of resistance in crop pests to insecticides. (Caprio et al 2006).

POPGEN-SM

The stochastic model POPGEN-SM is a modification of an earlier stochastic, spatially explicit, dual locus, simulation model designed to evaluate development of resistance in crop pests to insecticides and incorporating multi loci. (Caprio et al 2006).

To incorporate uncertainty in the parameters used in the deterministic model, distributions, based on data for the lowest and maximum possible values, were developed as well as a most likely value. These values were used in PERT distributions based on a beta distribution with the most likely value weighted by 4 (Vose 2001).

Dr. David Onstad of the University of Illinois commented that it was difficult to understand EPA's modeling because insufficient detail on the design and inputs was included in the docket for the initial registration. We recognized that it would have been useful to place more information on the modeling in the docket. Unfortunately, this information was not ready for release at the start of the comment period. We supplemented the docket with additional information on the model and model inputs during the comment period. Dr. Onstad also suggested that EPA's modeling efforts should be more transparent and should include more explicit explanation of how the modeling was conducted. We hope that the additional information provided to the docket addressed the concerns regarding transparency. Also, EPA will convene a public meeting of the SAP to evaluate these models in early December. We urge all interested parties to participate and submit comments at that time. Additional information on this meeting of the SAP will be available within the normal time frame.

*5% Seed Blend*

Subsequent to the February 2009, FIFRA Scientific Advisory Panel meeting, Pioneer submitted revised modeling that incorporated new corn rootworm movement data. EPA fully evaluated this modeling, including assessing the new corn rootworm movement data. In addition, using the POPGEN model developed by EPA ORD, EPA conducted an independent modeling analysis of Pioneer's proposed seed blend using both deterministic and stochastic models. EPA concluded that a number of critical input parameters to the Pioneer modeling were not supported by data or were inadequate to support a rational basis for regulatory decisionmaking. Therefore, BPPD concluded that the results of the Pioneer modeling indicating that the proposed 5% seed blend is superior to a 20% block refuge deployment strategy for OAM1 and corn rootworm were not scientifically supported.

EPA had concerns regarding Pioneer's assumptions about short range insect dispersal because the data (Nowatzki et al. 2003) were limited, and were derived from only one location in the cornbelt. This was a critical factor because the adult insect dispersal input is a sensitive parameter for modeling the durability of block refuges. Parameter inputs representing a shorter dispersal range lowered the resulting effectiveness of a block refuge. Using a range of representative parameter values and assumptions to predict the durability of a 20% block refuge

versus Pioneer's proposed 5% blended refuge, EPA's deterministic modeling showed that the predicted durability for the 20% block refuge was superior to a 5% seed blend strategy (11.95 years vs. 8.1 years).

In addition to the 5% seed blend, EPA modeled other blend percentages for comparison. A 10% seed blend was predicted to have a durability of 11.3 years, which was slightly less durable (5.4%) relative to a 20% block refuge based on EPA's assumptions. EPA concluded, however, that these results were of limited actual utility because a number of parameter inputs to the original Pioneer model did not reflect actual variability and/or uncertainty. Therefore, to assess the current application for a 10% blended refuge, EPA conducted modeling using a range of representative input parameters.

*10% Seed Blend*

In the latest modeling, EPA incorporated uncertainty by using probabilistic distributions of critical data that we determined to be variable and/or uncertain. The distributions were developed based on acceptable data for the minimum, maximum, and most likely, possible values. These values were developed as PERT distributions. Each model was run 2,000 times, and each run utilized input parameters drawn from the PERT distributions. "Resistance" was defined as the resistance allele exceeding 50%, and EPA measured the mean, 25$^{th,}$ and 75$^{th}$ percentiles of the time to "resistance." EPA also determined the proportion of simulations where the time to resistance exceeded 11 years. (The SAP has advised that 15 years with no resistance is a reasonable goal for an IRM program applicable to a single-gene toxin. The Cry34/35 transgenic toxin has been in use for four years. Therefore, we believe it relevant to assess how many of the model runs indicate that either the 20% block or the 10% blend will delay development of resistance for 11 or more years.) The data from these model simulations indicate comparative durability values of 11.3 years for the 10% blended refuge and 20.2 years for the 20% block refuge. Thus, the 10% blend was 45% less durable than the 20% block refuge currently required for single trait CRW PIPs.

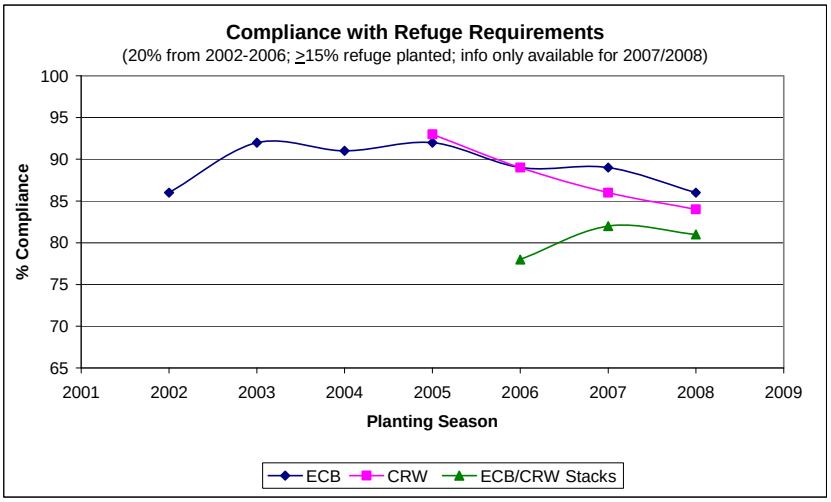
**IRM Refuge Compliance**

Critical to an assessment of the likely efficacy of an IRM mitigation program is the level of compliance with that program. Data received by EPA from the Agricultural Biotechnology Stewardship Technical Committee (ABSTC) indicate that compliance with the paradigmatic 20% block refuge requirement for most *B.t.* corn crops has been steadily decreasing. As noted by a number of commenters, this decreased compliance increases the risk of resistance development (see, e.g., *Complacency on the Farm*, CSPI 2009, and *Impact of Genetically Engineered Crops on Farm Sustainability in the United States,* NAS 2010*)*.

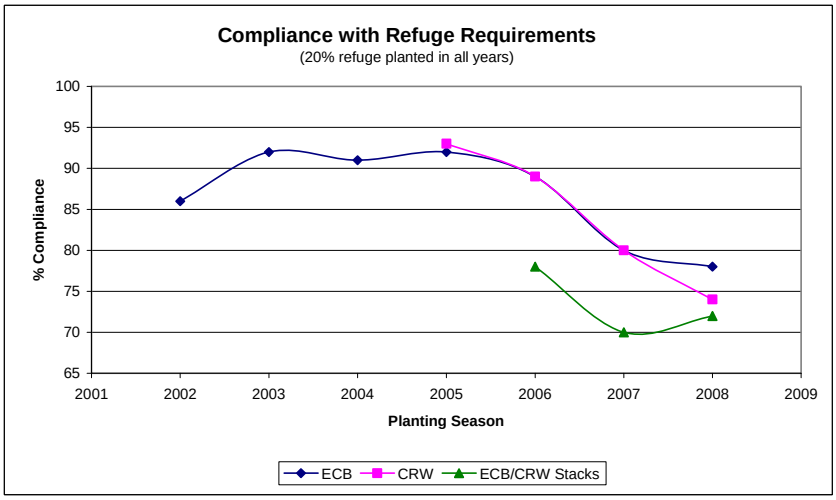
For the 2002 to 2008 planting seasons, ABSTC reported refuge compliance either as ‘all compliant' (i.e., always planting a 20% refuge, within the proper distance) or 'out-of-compliance’ (i.e., not having either a 20% refuge, or having the refuge not located exactly where required, or neither). In 2007 and 2008, ABSTC began to also report if growers at least planted a 15% refuge or/and if most of a grower's *B.t.* fields met the refuge distance requirement. (Reporting these additional data reflects that there may be degrees of noncompliance, for example, a grower may be inadvertently out of compliance with distance requirements by a degree that does not materially affect the efficacy of the refuge. Also, while, admittedly, a 15% refuge is not

compliant with a 20% refuge requirement, it has a much different field impact than does a 0% refuge.)

The graphs below compare "out of compliance" versus "almost compliant" data. The upper graph is adjusted for 'almost compliant' growers in 2007 to 2008; the lower graph is the compiled out-of-compliance data from the ABSTC for 2007 and 2008. These data indicate that the unadjusted "out-of-compliance" values may not accurately reflect the actual impact of growers who are, technically, not compliant with the refuge requirements. Therefore, it may be that the "out of compliance" numbers reported recently may indicate a greater degree of risk of resistance developing than is actually the case.




| | ECB | CRW | ECB/CRW Stacks |
|---|---|---|---|
| 2002 | 86 | | |
| 2003 | 92 | | |
| 2004 | 91 | | |
| 2005 | 92 | 93 | |
| 2006 | 89 | 89 | 78 |
| 2007 | 89 | 86 | 82 |
| 2008 | 86 | 84 | 81 |




| | ECB | CRW | ECB/CRW Stacks |
|---|---|---|---|
| 2002 | 86 | | |
| 2003 | 92 | | |
| 2004 | 91 | | |
| 2005 | 92 | 93 | |
| 2006 | 89 | 89 | 78 |
| 2007 | 80 | 80 | 70 |
| 2008 | 78 | 74 | 72 |

## III. BENEFITS

We expect OAM1 to have the following benefits: (1) Reduced pesticide use in the refuge. Currently, the 20% block refuge may be sprayed with pesticide to mitigate pest damage. The blended in-field refuge will not be sprayable. (2) Significantly less complicated refuge deployment for the corn rootworm active ingredient. Currently, to be fully compliant with the

refuge requirements, growers must accurately calculate 20% of the field, accurately determine the proper distance for the refuge field, and properly plant the required acreage in the correct location. Moreover, there are temporal concerns, as the refuge field must be planted at, essentially, the same time as the yield field so that emergence of refuge rootworms is contemporaneous with emergence of field rootworms. Anecdotal reports from growers make clear that meeting each of these requirements can be challenging in the actual on-farm environment. A product with the refuge blended with the field seed will ease deployment of the rootworm refuge. (3) Increased grower compliance with IRM requirements for the corn rootworm active ingredient. A seed blend product incorporating an effective refuge in the seed bag would lead to 100% grower compliance for planting a refuge. This is a significant benefit, although perhaps not as great as the raw data on refuge compliance might suggest.

In addition, *indirect benefits* of introducing Optimum® AcreMax™ 1 may include reduced energy consumption for manufacture, transport, and application of chemical insecticides; reduced waste streams arising from pesticide manufacture; reduced disposal of pesticide waste containers; and reduced residues from pesticide applications.

**Efficacy and Yield Benefits**

Pioneer conducted a two year study (2006 to 2007) to assess efficacy and yield benefits of a blended seed refuge. The purpose of the study was to determine the effects of a blended refuge approach on field standability, root ratings, and yield (three effects measured at each treatment level). The 2006 experiment was replicated at eight different locations in a randomized block design with four replicates for all five treatments. The treatments were: (1) untreated control; (2) conventional seed treated with P1250; (3) 100% HXRW (HERCULEX® RW) seed treated with P250; (4) 10% seed mix of conventional seed treated with P250 and 90% HXRW seed treated with P250; and (5) 20% seed mix of conventional seed treated with P1250 and 80% HXRW seed treated with P250. During July 2006, five roots per plot were randomly selected, root damaged scored using the Iowa State 0-3 node injury scoring, and yield determined at end of the growing season. Under low insect pressure, Pioneer reports little difference in node injury or yields between treatments (no data provided). Under high insect pressure, all HXRW treatments had approximately equal grain yield and node injury and the 10% and 20% seed blends were equivalent to the control of 100% HXRW maize.

The Center for Science in the Public Interest (CSPI) commented that our analysis of the benefits of OAM1 should consider overall IRM compliance, including that in the lepidopteran refuge. In addition, CSPI stated that EPA should require additional conditions related to the lepidopteran refuge, such as requiring that refuge requirements be placed on seed bags, requiring that on-farm assessments be conducted by third parties, requiring growers to certify compliance annually, and separating compliance data into geographic regions. EPA agrees with and is implementing a number of these suggestions. Pioneer has committed to including labeling on OAM1 seed bags indicating the size of the required refuge for lepidoptera, and this is being made a specific term of the registration. (We note that this is also being made a term of all B.t. corn registrations and that all B.t. corn registrants are required to make best efforts to implement this change on as many bags of seed as possible for the 2011 growing season, on 50% of seed bags for the 2012 growing season, and on 100% of seed bags for the 2013 growing season). EPA is also requiring that on-farm assessments for all B.t. corn registrations must be conducted by independent, third-parties. Also, compliance data will be required to be submitted in a form that will permit

evaluation by geographic region. We are not, at this time, requiring that growers annually certify *ex post facto* that they complied with the IRM requirements; but, that is a requirement that we will consider in the future, should the compliance picture not improve.

Dow AgroSciences commented that the requirement for a separate structured lepidopteran refuge would create confusion among growers. We agree that there is the possibility of grower confusion related to the fact that there must be two separate refuges for OAM1. Pioneer is required to conduct enhanced grower education to ensure that purchasers of OAM1 understand the lepidopteran refuge requirements. Pioneer also is responsible for 2000 independent, third-party on-farm assessments to address compliance with the lepidopteran refuge requirements. Significant non-compliance with the OAM1 lepidopteran refuge requirements, if verified, could have implications for continued availability of OAM1 in 2011 and beyond .

In 2007, the study was repeated with the addition of HX1 (HERCULEX® I) as refuge seed (treated with P250 and P1250). BPPD did not see statistically significant differences between node injury, % root lodging, and grain yields between any of the HXX (HERCULEX® XTRA) treatments except with respect to node for the 20% refuge with P250.

## IV. REGULATORY RATIONALE

### A. 2010 Registration Decision

Section 3(c)(7)(A) of FIFRA provides for the registration or amendment of a pesticide when the pesticide and proposed use "…are identical or substantially similar to any currently registered pesticide and use thereof, or differ only in ways that would not significantly increase the risk of unreasonable adverse effects on the environment, and (ii) approving the registration or amendment in the manner proposed by the applicant would not significantly increase the risk of any unreasonable adverse effect on the environment." Unreasonable adverse effects on the environment are defined under Section 2(bb) of FIFRA as "… any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide…" Thus, pursuant to Section 3(c)(7)(A), EPA may conditionally register a pesticide if (1) the pesticide and its proposed use are identical or substantially similar to a currently registered pesticide; or (2) the pesticide and its proposed use differ only in ways that would not significantly increase the risk of unreasonable adverse effects; and (3) approving the registration would not significantly increase the risk of any unreasonable adverse effect.

In our registration decision for the 2010 growing season, we found that OAM1 and OAM RW met criteria (2) and (3) of Section 3(c)(7)(A) for a time-limited registration to expire September 30, 2010. Optimum Acre Max (OAM) 1 is a seed blend consisting of two currently registered products, 90% Herculex Xtra and 10% Herculex I. Optimum Acre Max (OAM) RW is a seed blend consisting of an already registered product and non-PIP corn, 90% Herculex RW and 10% non-B.t. corn. Thus, both products were found to be substantially similar to already registered PIPs in composition and use site (field corn). These products did not meet criteria (1), however, because the proposed use of OAM1 and OAM RW that achieves the insect resistance management refuge via a seed mix rather than a block refuge is not substantially similar to any currently registered pesticide. Having the refuge in the bag of seeds is a novel approach.

We determined, however, that each of these products met criteria (2) as, when used in accordance with the terms and conditions of the time-limited registration set to expire September

30, 2010, neither would significantly increase the risk of unreasonable adverse effects on the environment. Since OAM1 and OAM RW are substantially similar to already registered PIPs in composition and use site, EPA's consideration of whether these new products would significantly increase the risk of any unreasonable adverse effect on the environment was limited to the change in insect resistance management refuge deployment and percentage, i.e., a 10% seed blend in the bag versus a 20% block refuge. The unreasonable adverse effect of concern was the development of resistance to Cry34/35Ab1 in corn. Thus, we considered: (1) how does the registration of OAM1 and OAM RW contribute to the development of corn rootworm resistance to Cry34/35Ab1 corn; (2) should this resistance develop, what risk does it pose to man or the environment; and (3) taking into account the economic, social, and environmental costs and benefits, does this risk constitute an unreasonable adverse effect?

**The Risk of OAM1 and OAM RW Registrations Causing CRW Resistance to Cry34/35Ab1**

The modeling used by EPA to assess IRM strategies utilizes comparative simulation models. The model durability output, years to resistance, is intended to be used for comparative purposes to evaluate different refuge options on a relative basis. The durability outputs that EPA determined for the proposed 90% CRW protected seed/10% non-CRW protected seed blend, and a 20% block refuge are 11.3 years to resistance, and 20.2 years to resistance, respectively. Thus, our analysis indicated that, as modeled, the proposed seed blend is 45% less durable on a comparative basis than the 20% block refuge currently required for single trait CRW PIPs .

Besides the currently registered Pioneer PIPs, Cry34/35Ab1 corn is registered in a number of other *B.t.* corn PIPs, including multi-CRW *B.t.* toxin products, by Monsanto and Dow AgroSciences. Should resistance develop to Cry34/35 in a OAM1 seed blend, these other products could be adversely affected including potential loss of efficacy and viability as CRW control tools. We note, in particular, the recent statement of the National Research Council to the effect that ". . . results from simulation models and small-scale laboratory experiments indicate that the evolution of resistance to two-toxin cultivars is accelerated when plants that produce two *B.t.* toxins are grown near plants that produce just one toxin." National Academy of Sciences, *Impact of Genetically Engineered Crops on Farm Sustainability in the United States,* 2-37 (2010). Based on our assessment, we concluded that significant acreage of a 10% seed blend with a single, non-high dose mode of action such as Cry 34/35Ab1 likely increases the risk of resistance for all *B.t.* corn products containing Cry34/35Ab1. But, the time-limited registration expiring September 30, 2010, likely would not increase the risk of resistance to Cry34/35Ab1.

Pioneer projected that the time-limited registrations granted for the 2010 growing season would result in planting on only approximately 0.042% of acres of non-Red Zone geography corn acres; and only on approximately 0.077% of Red-Zone geography corn acres. In the context of 90 million acres of corn planted in the United States annually, we concluded that plantings on such limited acreage would not have effects on CRW resistance development.

The ad hoc members of the SAP commented that the evolution of resistance that occurs as a result of OAM1 presence in the field will speed resistance to Cry34/35 pyramided products. Comments from Dow Agrosciences and Syngenta also expressed concern that OAM1 would impact other PIP products and speed resistance evolution. CSPI commented that if the registration decision was based in part on sales projections, then acreage caps should be a term of the registration. We appreciate the concerns of the ad hoc members of the SAP, Dow

Agrosciences, and Syngenta regarding the potential of OAM1 to accelerate evolution of resistance to Cry 34/35. This is a concern that we share. We took steps and imposed terms on the OAM1 registration for the 2010 growing season to address these concerns. Pioneer was required to implement an enhanced resistance monitoring plan for OAM1 that included benchmark studies showing susceptibility of the western corn rootworm populations (WCRW) in the Sublethal Seedling Assay. These studies must be submitted by December 1, 2010. Pioneer must attempt to obtain benchmark susceptibility data using the Sublethal Seedling Assay for the northern corn rootworm as well, and submit such studies by December 1, 2011. Pioneer must also submit by December 1, 2010, a detailed OAM1-specific resistance monitoring and remedial action plan, including an analysis to determine the expected field performance criteria for OAM1 products so that unexpected damage can be benchmarked. This plan will be updated by December 1, 2012, if needed, based on continued field evaluation of OAM1 performance. Pioneer was also required to develop programs to evaluate whether there are statistically significant and biologically relevant changes in target insect susceptibility to Cry1F and Cry34Ab1/Cry35Ab1 proteins in the target insects; and a remedial action plan that must set forth the specific measures Pioneer will take in the event that any field-relevant insect resistance is detected. While we are not requiring specific acreage caps as part of the registration for 2011 and 2012, we will closely monitor the extent of sales and plantings of OAM1, as well as all insect monitoring data. In the event there is any indication of resistance evolution, Pioneer must report that to EPA immediately. We will assess all data and information relevant to the indication of resistance evolution and, if we determine that such action is appropriate, will use our authority under Section 6(c) of FIFRA to suspend the registration.

**Should Resistance Develop, What *Risk Does it Pose to Man or the Environment, and What Economic and Social Costs*?**

Should Cry34/35Ab1 resistance develop, there would be an increase in conventional chemical insecticide use for U.S. corn production. Although there are other CRW controlling PIPs in the marketplace and under development, Cry34/35Ab1 resistance would not only impact OAM1 and OAM RW, but also HERCULEX® RW, HERCULEX® XTRA, and Genuity™ SmartStax™. Increased use of conventional insecticides would increase impacts on the environment and man. There would also be indirect impacts in increased energy consumption for manufacture, transport, and application of chemical insecticides; increased waste streams arising from pesticide manufacture; and increased disposal of pesticide waste containers and residues from pesticide applications.

**What are the Economic, Social, and Environmental Benefits of OAM1 and OAM RW?**

Both OAM1 and OAM RW have been determined by EPA to be efficacious in their control of corn rootworm.

OAM1 and OAM RW should increase grower compliance with CRW refuge requirements by providing a novel and effective way of simplifying the refuge deployment process for growers as the corn rootworm refuge is deployed as a seed blend rather than a separate block in the field.

OAM1 and OAM RW should also reduce the insecticide use in the CRW refuge and in the CRW-PIP fields. Currently, corn rootworm PIP products require insecticide treatment of the PIP acreage, even if economic thresholds are not reached. This use of insecticides solely to support the management of resistance has been required if aerial insecticides are applied to the refuge for control of CRW adults or if pests other than adult corn rootworms are treated with CRW-labeled

insecticide on the refuge acres when adult corn rootworms are present. OAM1 and OAM RW would reduce this IRM based use of insecticides. Indirect benefits of decreased insecticide use include reduced energy consumption for manufacture, transport, and application of chemical insecticides; reduced waste streams arising from pesticide manufacture; reduced disposal of pesticide waste containers and residues from pesticide applications.

OAM1 and OAM RW should benefit growers by simplifying the planting process.

## Registration Decision for 2010 Growing Season

We concluded that OAM1 and OAM RW met the criteria for registration under FIFRA Section 3(c)(7)(A). Our assessment supported the determination that these products are not likely to contribute towards the development of resistance of CRW to Cry34/35Ab1 during the period of the time-limited registration in effect for the 2010 growing season. Our assessment of the likely impacts concerning ease of use, increased grower compliance, efficacy, and reduced insecticide use coupled with our determination that OAM1 and OAM RW are not likely to increase the risk of resistance of CRW to Cry34/35Ab1 developing during the 2010 growing season supported the conclusion that the criteria under FIFRA Section 3(c)(7)(A) were met such that registration of OAM1 and OAM RW would not pose a risk of unreasonable adverse effects on the environment during this period.

On October 1, 2009, EPA announced a new policy to provide a more meaningful opportunity for the public to participate on major registration decisions before they occur. According to this new policy, EPA intends to provide a public comment period prior to making a registration decision for, at minimum, the following types of applications: new active ingredients; first food use; first outdoor use; first residential use; and other actions for which the Agency anticipates that there will be significant public interest.

Notwithstanding that the current actions on OAM1 and OAM RW qualify as "actions for which the Agency anticipates that there will be significant public interest," EPA believed that it was in the best interests of the public and the environment to issue the registrations for OAM1 and OAM RW without delay. The PRIA (Pesticide Registration Improvement Act) deadline date of May 1, 2010, was sufficiently late in the growing season that a 30-day delay would have lessened the likelihood that significant acreage of these products could be planted in 2010. Given the potential benefits attendant to the blended refuge concept, EPA concluded that it was in the best interests of the public and the environment to issue the registrations for OAM1 and OAM RW without delay for 2010 growing season. The registration is only effective for the current growing season. Therefore, consistent with the Agency's policy for making certain registration actions more transparent, EPA issued these time-limited registrations with an initial period to expire September 30, 2010, and, concurrent with their issuance, provided a 30-day public comment period on the time-limited registrations. EPA registered this product as a time-limited registration, with the understanding that public comments could bring to light new information or concerns that could inform EPA's initial decision. Any subsequent action taken on these registrations will be informed by any information received during the public comment period.

CSPI commented that the public participation process for the OAM1 registration for the 2010 growing season was inadequate. CSPI believed that the opportunity for public comment should

have occurred prior to the registration decision. We do not disagree with the comment. All things being equal, however, we felt that it was important to meet the PRIA due date for this action, and that taking public comment concurrent with the registration would not unfairly deprive the public of the opportunity for meaningful comment, nor deprive us of the benefit of public input. The OAM1 2010 registration was a very short, approximately five-month, time limited registration that was only good for one growing season. Moreover, as noted in the April 30, 2010, BRAD, the timing of the registration was so late in the growing season that it precluded significant sale and planting of the product. As it happened, data submitted by Pioneer (Rood, 2010), verified that OAM1 acres for 2010 amounted to only 39,000 acres, which is less than projected in the earlier BRAD. We are pleased that we did receive meaningful comment on the April 30, 2010, registration action, and that that comment has been useful in informing the preliminary decision that we are announcing today. The OAM1 registration that we are proposing today contains a number of enhanced requirements for corn rootworm resistance management that we believe will have a propitious impact not only on this registration, but on other B.t. corn registrations as well. Finally, comments received on the OAM1 registration played a significant role in EPA's deliberations on the concept of tiered time-limited registrations. As discussed below, we believe that it makes sense to make a specific connection between the risk of resistance evolving that a particular product presents and the time permitted for the registration of that product to be in effect. Products that we determine through scientific evaluation to meet a stringent standard for protecting against the risk of resistance evolving will be eligible for a registration of up to fifteen years. CSPI also commented that EPA "stealthily" released the OAM1 BRAD, and did not announce the comment period either in the Federal Register or by press release. We can assure all concerned that the intent was not to be "stealthy." EPA opened the public comment period for this action as it has done for all other actions subject to the new public participation initiative, i.e., by announcing the comment period on the Agency's public participation webpage. This comment points out to us, however, that there are instances where more extensive efforts to publicize the initiation of a comment period and the availability of BRADs, etc., may be warranted. We undertook such efforts in conjunction with the B.t. corn registrations comment period.

## B. Registration Decision for 2011 and 2012 Growing Seasons

In the April 30 BRAD, we preliminarily concluded that our modeling analysis combined with the Pioneer sales projections for the 2011 and 2012 growing seasons supported continued registration of OAM1 and OAM RW for 2011 and 2012. We noted that Pioneer predicts OAM1 and OAM RW acreage to increase up to 8% of the Red Zone and 12% of the non-Red Zone. EPA invited comments during the 30-day comment period on the preliminary decision to register OAM1 and OAM RW for the 2011-2012 growing seasons. Important to this preliminary decision was the fact that Pioneer committed to additional elements that would enhance the IRM plan applicable to OAM1 and OAM RW regarding insect resistance monitoring and remedial action should resistance be detected, and the refuge assurance program. These were listed in detail in the terms and conditions of the April 30, 2010, OAM1 and OAM RW registrations.

Section 3(c)(7)(A) of FIFRA provides for the registration or amendment of a pesticide when the pesticide and proposed use "…are identical or substantially similar to any currently registered pesticide and use thereof, or differ only in ways that would not significantly increase the risk of unreasonable adverse effects on the environment, and (ii) approving the registration or amendment in the manner proposed by the applicant would not significantly increase the risk of any unreasonable adverse effect on the environment." Unreasonable adverse effects on the

environment are defined under section 2(bb) of FIFRA as "… any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide…" Thus, pursuant to section 3(c)(7)(A), EPA may conditionally register a pesticide if (1) the pesticide and its proposed use are identical or substantially similar to a currently registered pesticide; or (2) the pesticide and its proposed use differ only in ways that would not significantly increase the risk of unreasonable adverse effects; and (3) approving the registration would not significantly increase the risk of any unreasonable adverse effect.

The Agency concludes that the following Cry34/35Ab1 corn product registrations, set to expire September 30, 2010, and described in-depth throughout this BRAD, meet both criteria (1) and (2):

(1) Optimum® AcreMax™ 1 (OAM1) => Seed Blend of 90% HERCULEX® XTRA and 10% HERCULEX® I

(2) OAM RW => Seed Blend of 90% HERCULEX® RW and 10% Non-*B.t.* Corn

Each of these Cry34/35Ab1 corn products are identical in both composition and use (field corn) to plant-incorporated protectants that are currently registered. Thus, criterion (1) has been fulfilled. With regard to criterion (2), the Agency maintains, as was previously determined for the original registration of these particular products, that cultivation of Cry34/35Ab1-containing corn will not cause unreasonable adverse effects on the environment. The conditional environmental effects data, submitted in response to terms and conditions of registration and summarized in section II(C)(2)(b) of this BRAD, strengthen the Agency's initial position and also confirm that long-term effects on non-target organisms are not anticipated. Lastly, the continued use of these products will likely still provide many of the benefits as were evaluated to support the OAM1 registration for the 2010 growing season (e.g., reduction in use of conventional insecticides that are highly toxic to both humans and the environment; increased compliance with CRW refuge requirements).

In conclusion, as the expiring Cry34/35Ab1 products (Optimum® AcreMax™ 1 (OAM1) => Seed Blend of 90% HERCULEX® XTRA and 10% HERCULEX® I; and OAM RW => Seed Blend of 90% HERCULEX® RW and 10% Non-*B.t.* Corn) have met the required criteria under section 3(c)(7)(A) of FIFRA, the Agency has amended these registrations to extend their respective expiration dates as follows:

| Product Name (EPA Reg. No.) | Proposed Expiration Date |
|---|---|
| OAM1 (29964-6) | September 30, 2012 |
| OAM1 RW (29964-10) | September 30, 2012 |

Although data provided were satisfactory to make the determinations required by section 3(c)(7)(A) of FIFRA, they were not sufficient to support an unconditional registration under FIFRA section 3(c)(5). Additional data, specifically in relation to insect resistance management are necessary for a finding of registrability under FIFRA section 3(c)(5) and remain as terms or conditions for the purposes of the proposed amendments.

## C. Period of Registration

In the 2001 *Bt* Corn reassessment, EPA determined that it was appropriate to amend the then-existing registrations to extend the period of registration of those products to an expiration date of October 15, 2008. All of the products being assessed at that time were efficacious against lepidopteran pests. EPA based this action on the finding that use of Cry1Ab or Cry1F expressed in corn will not significantly increase the risk of unreasonable adverse effects on the environment "for the limited time period of 7 additional years (to October 15, 2008)." These registrations were later amended to extend the period of registration to an expiration date of September 30, 2010. EPA subsequently granted time-limited registrations to products efficacious against coleopteran corn rootworm pests. For example, EPA registered Cry3Bb1 on February 24, 2003, to May 1, 2004, and extended that registration twice, to February 24, 2008, and September 30, 2010.

As set forth elsewhere in this document, EPA's primary concern for the *Bt* protected transgenic corn products is the possibility that target pests will develop resistance to one or more of the plant-incorporated protectant (PIP) toxins. Development of resistance to a *Bt* toxin would be a grave adverse effect, and, for over 15 years, EPA has imposed stringent requirements intended to countermand the potential development of resistance. Registrants similarly have been busily developing various products, product mixes (i.e., so-called "pyramids" and "stacks"), and resistance strategies, to maximize agronomic benefits and address resistance management issues. The result has been a vast array of product combinations and, occurring over the past couple of years, a re-emergence of varying refuge requirements for different products.

As discussed in the 2001 *Bt* PIP BRAD (at IID13), the earliest *Bt* corn registrations did not include mandatory refuge requirements. There was a lack of scientific consensus as to what the appropriate refuge requirement should be, and, it was assumed that the limited market penetration of these early crops would be so low as to guarantee that adequate natural refuges would be available from neighboring non-*Bt* corn fields. From 1995 to 1997, *Bt* corn registrations included voluntary refuge requirements of 0% to 20% in the Corn Belt. In 1999, the Agricultural Biotechnology Stewardship Technical Committee (ABSTC), in conjunction with the National Corn Growers Association, proposed uniform insect resistance management (IRM) requirements for *Bt* corn registrations. With some modifications, this proposal, put in place for the 2000 growing season, formed the baseline IRM requirements for almost all *Bt* corn registrations for the better part of a decade: farmers were required to plant a 20% refuge that could be treated for insects, or a 50% treated refuge in cotton-growing areas; all refuges to be planted within one-half mile of the *Bt* corn field.

These uniform requirements brought certainty and consistency to the market after the initial period where many *Bt* corn products had different refuge requirements. Recently, however, as product developers have begun to conceive of products with different combinations of "pyramided" products (i.e., products containing two or more toxins efficacious against the same pest) and "stacked" products (i.e., products combining toxins efficacious against different pests), the refuge requirements have begun to vary. For example, certain products require a 20% external refuge; some products permit a 5% external refuge; one product incorporates a 10% seed blend refuge; we have applications in process for products that propose to incorporate a 5% seed blend refuge; and other permutations are possible.

Given the profusion of various toxin combinations and refuge options, we can no longer proceed

on the basis that, as concerns insect resistance management, all products are equal. It was a relatively simple proposition when the default requirement of a 20% sprayed refuge applied to almost all of the *Bt* corn crops in the market. Under those circumstances, the relative durability of products against the development of resistance was functionally equivalent, and, as a consequence, imposing functionally equivalent registration periods was appropriate. That is now no longer the case.

As part of our continually evolving regulatory approach to the continually evolving product mix wrought by developers, we think it appropriate to revise our regulatory requirements in scientifically defensible ways to reflect the comparative level of risks posed by the products that we regulate. Here, for example, where we've determined that a particular product, or category of products, likely will pose less risk of insect resistance developing to a particular PIP protein, we think it appropriate to grant that particular product, or category of products, a registration for a period greater than that granted a corresponding product that poses a greater risk of insect resistance developing. This approach is reflective of complementary principles: first, to ensure that we apply our limited resources to the products that pose greater risk of adverse effects to the environment; and, second, to conserve the resources that registrants and applicants must expend in amending the registrations of products that pose less risk of adverse effects to the environment.

The scheme that we are following includes registration periods of five, eight, and twelve years; a fifteen-year registration period will also be available, if adequately supported by our science assessment. In this scheme, (i) a product with a single PIP toxin, and a 20% external refuge, qualifies for a five-year registration; (ii) a product with pyramided PIP toxins (i.e., two or more toxins with distinct, non-cross reacting modes of action), that are non-high dose (the definition for a high dose product remains unchanged), with either a seed blend or external refuge, qualifies for an eight-year registration; (iii) a product with pyramided PIP toxins (i.e., two or more toxins with distinct, non-cross reacting modes of action), that are high-dose, with either a seed blend or external refuge, qualifies for a twelve-year registration; (iv) a product with pyramided PIP toxins (i.e., two or more toxins with distinct non-cross reacting modes of actions), with either a seed blend or external refuge, that has been determined by EPA's science assessment to be 150% as durable as the baseline single toxin product with a 20% external refuge, would qualify for a fifteen-year registration. Products determined by EPA's science assessment to be less than 100% as durable as the baseline single toxin product with a 20% external refuge would not qualify for a five-year registration and the registration period for such products will be determined on a case-by-case basis consistent with the level of risk they pose. Similarly, instances where other risk issues may arise, or where novel resistance concerns may be present, would also be determined on a case-by-case basis, as will novel refuge configurations that may present unique durability profiles.

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