IRAC Position on Seed Blends for IRM

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Prepared by: IRAC International Plant Biotechnology Committee

Seed Blends for Resistance Management of Insect-Protected Transgenic Crops

IRAC International Plant Biotechnology Committee

Background

Until recently, seed blend refuges (aka "Refuge in the Bag") for insect resistance management have not been favored by the agricultural biotechnology industry. Barriers to their implementation result from concerns about the movement of larvae among insect-protected and unprotected plants. Larval movement can reduce the dose experienced by the insects, potentially favoring the survival of heterozygotes over susceptible genotypes, and can reduce the proportion of insects that undergo no selection. In addition, the relatively large required refuges, at least in the U.S., have made such products unattractive to growers.

More recently, advances in insect-protected crops and improved understanding of insect biology have indicated potential advantages of blended refuges. Products that are not high dose against their key target pests, those that have smaller refuge size requirements, and those containing pyramided traits reduce the concerns previously raised. Today, there are several insect-protected transgenic crops available as blended refuge products. For example, in the US Corn Belt, the industry is rapidly moving to pyramided Bt corn products with 5% blended refuge for corn borers and corn rootworms. The advantages of blended refuge products are maximizing refuge implementation and the inter-mating of resistant with susceptible insects, both important to extending trait durability.

Here we describe considerations to guide decisions on whether a seed blend refuge strategy may be appropriate for an insect-protected transgenic crop.

Technical Advantages and Disadvantages of Refuge Seed Blends for IRM

Advantages

- Refuge implementation is controlled by the seed supplier, not the grower.
- Seed supplier ensures the refuge variety has appropriate agronomics.
- Refuge and traited plants receive identical agricultural treatment (fertilizer, irrigation, insecticide etc).
- Refuge cannot be planted on inferior land
- Does not rely on adult insect dispersal to ensure most adults emerging from traited plants mate with adults emerging from refuge plants.
- The "halo effect" arising from reduced larval survival on Bt plants can result in reduced damage to refuge plants.

Disadvantages

- Larvae that move among plants experience reduced dose of insecticidal trait.
- Larval movement off refuge plants can reduce effective refuge size.
- Insect pests on refuge plants cannot be managed separately from those on traited plants.
- Older larvae moving from refuge plants can cause injury to traited plants.

Indicators Favoring Refuge Seed Blends

Seed blend refuge may be appropriate when one or more of the following apply (the more factors that apply, the stronger the case for blended refuge over structured refuge):

- Single-trait less-than-high dose product with small required refuge percentage (≤ 10%)
- Pyramided product (i.e., with more than one mode of action against the target pest) that requires small refuge (≤ 10%) and has long expected durability
- Compliance with structured refuge requirements or guidelines is low
- Target pests exhibit limited pre-mating dispersal of adults
- Target pests exhibit limited larval movement among plants (especially for a single-trait high-dose product)
- Little or no natural refuge is present

Additional Considerations

Biological considerations:

- For target pests against which the crop is a high dose, that exhibit high inter-plant mobility as larvae, and that have significant natural refuge, seed blends can be worse than no structured refuge.
- A suitable IRM strategy for one target pest may be less suitable for other target pests.
- Management programs for pests not targeted by the traits may need to be modified

Seed company operational considerations:

- Harmonized implementation from all seed suppliers will avoid growers choosing unblended seed and failing to plant the refuge.
- The agronomics of the refuge variety should be well matched to the transgenic insect-protected variety and contain the same herbicide tolerance traits.
- Quality assurance procedures need to ensure a consistent blend percentage

Grower implementation considerations:

- Potential for grower confusion over which seeds require a separate structured refuge must be addressed through education.
- Insect-protected seed with blended refuge may not be as attractive to growers as unblended seed.
- Growers' understanding of product performance and management may need to be clarified.

Legal and regulatory considerations:

- Local seed purity laws may complicate the production and distribution of blended refuge products.
- Some authorities may require separate regulatory authorization for blended refuge products.

Decision-making Pertaining to Seed Blends

Achieving needed planting of refuges is essential to realizing durability goals for insect-protected transgenic crops. Experience gained in the past decade of deploying these crops has proven that growers are unlikely to comply with refuge planting requirements unless provided incentives to do so. This reality often leaves IRM planners with no practicable options other than seed blend refuges. Seed blends shift the burden of compliance from millions of growers to the much smaller number of seed producers. However, the introduction of seed blends requires years of prior planning and corporate investment into breeding, engineering and field evaluations, as well as facilitation and training of seed producers.

IRM programs that do not achieve the necessary planting of refuges place the sustainability of insect-protected transgenic crops at serious risk. Therefore, seed blends should be evaluated especially for settings in which compliance with refuges cannot be reasonably expected of growers. Where empirical data demonstrate that seed blends are unacceptable, due for example to unacceptable yield reductions and/or insect movement, more complex incentives for planting of refuges may need to be considered.

In situations where regulations include resistance management requirements, regulatory approaches should reflect the scientific consensus on the IRM value of seed blends. Seed producers should decide individually whether and how to engage with the relevant authorities on the contribution of seed blends to the sustainability of insect-protected transgenic crops.

Conclusions

The use of blended refuge should be considered on a case-by-case basis, weighing the advantages and disadvantages. In general, if a planted refuge is biologically warranted to promote product durability, larval movement between traited and refuge plants is not expected to seriously compromise durability, and grower implementation of a separate refuge is known or expected to be low, seed blends can be a valuable option for refuge deployment.