IRAC-US Efforts in Puerto Rico

Graham Head

Puerto Rico:

The challenge of island populations

Spray Programs on Corn

aplicacion	estado				mode of action
1	V3	Dimethoate Asana	Dimethoate;esfenvalerate	fall armyworm leafhoppers, aphids	1,3
2	v3	Lorsban 4E	Chlorpyrifos	fall armyworm	1
3	v4	Permethrin + Larvin	permethrin Thiodicarb	fall armyworm and egg masses, aphids	1,3
4	v4	Asana Lannate 90S	Methomyl	fall armyworm, aphids	1
5	V6	Lorsban 4E	Chlorpyrifos	fall armyworm	1
6	V6	Asana XL + Larvin	Esfenvalerate Thiodicarb	fall armyworm and egg masses, aphids	1,3
7	V7	Permethrin+Sevin	permethrin carbaryl	fall armyworm	1,3
8	v7	Tombstone + Lannate 90S	Cyfluthrin Methomyl	fall armyworm, aphids	1,3
9	v7	Lorsban granular	Chlorpyrifos	fall armyworm	1
10	V8	Tracer	spinosad	fall armyworm	5
11	v8	Thionex Xentari Dipel	Endosulfan Bt Bt	fall armyworm;aphids,leaf hoppers	2,11
12	v8	Lorsban granular	Chlorpyrifos	fall armyworm	1
13	V9	Permethrin+Sevin	permethrin carbaryl	fall armyworm	1,3
14	v9	Avaunt Dipel Xentari	indoxacarb	fall armyworm	22A
15	v10	Asana Intrepid 2F	esfenvalarate Methoxifenocide	fall armyworm	3,18A
16	V10	Ecotec AG Xentari Dipel	S-Cyano Rosemary & peppermint oil	fall armyworm;aphids,leaf hoppers	una
17	V11	Tracer	spinosad	earworm, fall armyworm	5
18	v12	Intrepid 2F AzaDirect Sniper	Methoxyfenozide Bifentrin Neem	fall armyworm	3, 18A, 18B
19	Poll. 1	Avaunt Carbaryl	Indoxacarb Carbaryl	fall armyworm	1, 22
20	Poll. 1	Permethrin Thionex	Permethrin Endosu;lfan	fall armyworm;aphids,leaf hoppers	2,3
21	Poll. 2	Asana Avaunt	esfenvalerate indoxacarb	fall armyworm	3,22
22	Poll. 2	Intrepid 2F Tombstone	Methoxyfenozide Cyfluthrin	fall armyworm	3,18A
23	Poll. 3	Tracer	spinosad	earworm, fall armyworm	5
24	Poll. 3	Mustang Sevin	S-cyano Carbaryl	fall armyworm	1,3
25	Sen	Warrior Xentari Dipel	Lambda-cyhalothrin Bt Bt	earworm, fall armyworm	1,11,11
26	Sen	Oberon UFoil	Spiromesifen	earworm, fall armyworm, aphids, thrips	23
27	Sen	Permethrin Thionex	Permethrin Endosulfan	earworm, fall armyworm, aphids, thrips	2,3
28	Sen	Larvin Tilt	Thiodicarb Propiconazole	eggs, foliar diseases	1
29	Sen	Malathion Tombstone	Malathion Cyfluthrin		1,3

The Situation

- Spray programs include multiple MOAs but selection pressure is still high on early FAW generations in each of 3 growing seasons
  - Number of sprays: 29
  - Number of MOAs: 9
- Initially good control but the frequency and amounts of sprays needed has steadily increased and so have production costs
  - Significant resistance to multiple classes of insecticides
- How can selection pressure be reduced with limited MOAs?
  - Implement IPM that includes alternative control tactics
  - Rotate insecticide MoA's simultaneously area wide
  - Institute an area wide fallow period of 1-2 months to reduce

Possible Area-wide Rotation for Corn

	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Year 1	No Pyrethroids (3)	No OPs or Car (1)	No Spinosad (5)	FALLOW	No Indoxacarb (22)	No Methoxy fenozide (18)
Year 2	No endosulfan (2)	No Spiromefsin (23)	No Pyrethroids (3)	FALLOW	No OPs or Car (1)	No Spinosad (5)

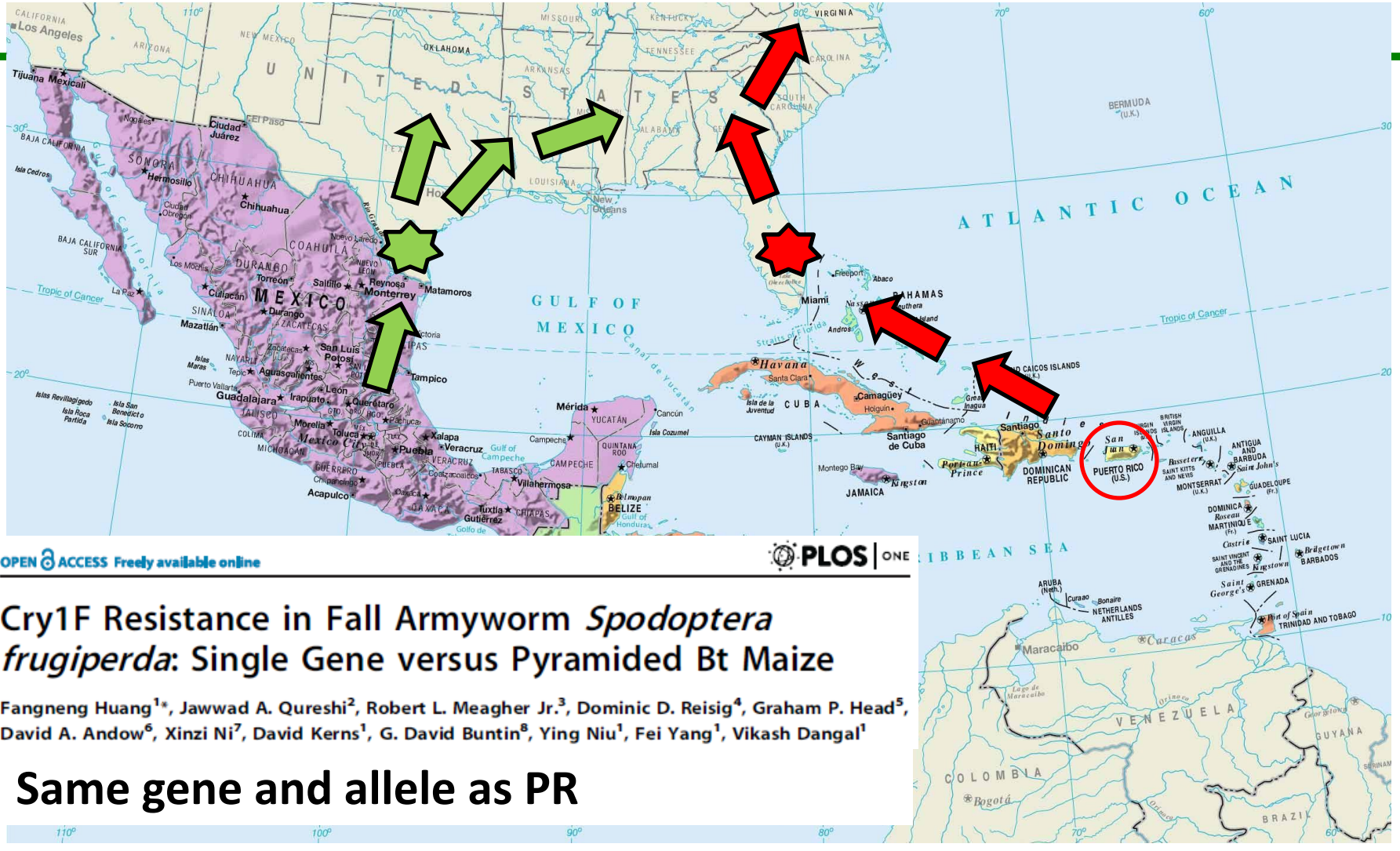
Integrate Control Strategies

- Monitor pests
- Focus on treatment thresholds rather than spray dates
- Preserve susceptible genes
  - Alternate different insecticides classes
  - Time applications correctly
- Use alternatives to chemicals such as sanitation, cultivation, and crop rotation or fallow periods
- Conserve beneficial insects
- Remove crop residue ASAP
- Implement area-wide window program
- Monitor insect susceptibility to measure progress

Outcomes of Original Funding

- IRAC funded a Masters student to assay across chemistry classes
- Encouraged industry participation in regular meetings
- Initial apparent commitment from the University but really only the Extension Lead
- Then … university imploded and the students went on strike. No support for project
- Seed Association did not take it seriously
- With the advent of Rynaxypyr registration, the growers had a tool that works well
- Funding discontinued

Bt-resistant FAW in Mainland USA



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PLOS ONE

Cry1F Resistance in Fall Armyworm *Spodoptera frugiperda*: Single Gene versus Pyramided Bt Maize

Fangneng Huang[1]*, Jawwad A. Qureshi[2], Robert L. Meagher Jr.[3], Dominic D. Reisig[4], Graham P. Head[5], David A. Andow[6], Xinzi Ni[7], David Kerns[1], G. David Buntin[8], Ying Niu[1], Fei Yang[1], Vikash Dangal[1]

Same gene and allele as PR

Monitoring with Soybean Looper (3X LC_{95})

Intrepid 2F	% mortality	
Location	2013	2014
Alabama	—	35
Arkansas	61	—
Georgia	57	55
Louisiana-AL	—	62
Louisiana-BH	69	—
Louisiana-NI	99	—
Louisiana-SJ	72	—
Louisiana-US	86	—
Mississippi	—	80
North Carolina	68	—
Puerto Rico	0	—
Tennessee	69	—

Belt SC	% mortality	
Location	2013	2014
Alabama	—	49
Arkansas	80	—
Georgia	70	74
Louisiana-AL	—	83
Louisiana-BH	87	—
Louisiana-NI	97	—
Louisiana-SJ	81	—
Louisiana-US	88	—
Mississippi	—	82
North Carolina	28	—
Puerto Rico	3	—
Tennessee	93	—

Next Steps for IRAC-US

- Re-engage IRAC members with local representation in Puerto Rico, with the aim of at least producing best practice recommendations for FAW across companies
- Understand whether a broader stakeholder coalition is needed and possible
- Collaborate with Louisiana State University and USDA-ARS to assess resistance status of soybean looper populations and the (genetic) relationship between Puerto Rico and mainland populations