

Complex Example

Below is an example for purposes of showing how this IPM evaluation tool can be used to analyze candidate pesticides for IR-4 consideration. It would not be customary or expected that information would be supplied for each cell in the matrix. Green cells indicate good IPM compatibility; Yellow cells indicate intermediate compatibility; and Red cells suggest a poor fit. : Situation. Safflower production in California is valuable to its producers but is keystone regionally to Lygus seasonal dynamics, resulting in large influxes of Lygus from safflower to cotton. Safflower is generally insensitive to Lygus damage; however, a well-timed effective insecticide spray could limit or eliminate the role that safflower serves as a source of damaging Lygus to cotton and other summer crops. In effect, this could change safflower from a source crop to a trap crop or effective regional sink for Lygus. No good Lygus insecticides are available for safflower. This is not a crop centric problem; it is a cropping system problem and as such an uncommon IR4 request. This is a request to address areawide dynamics of Lygus, not protection of safflower per se. But safflower is a critical rotational crop for the area, mitigating compaction (biotillage effects), short enough season to allow field operations before next crop, drought tolerant, enhances soil condition / structure and salinity management, reduces soil borne pathogen load for cotton and tomatoes.

Attribute	Affirmative Criteria	Intermediate Criteria	Negative Criteria
Efficacy			
Efficacy	Data from field trials under similar environmental/climatic conditions demonstrate good efficacy against target pest	Data demonstrating efficacy against target pest is from a different set of environmental/climatic conditions.	Data from field trials under a different set of environmental/climatic conditions demonstrate marginal or inconsistent efficacy
Novaluron (Expert 1)		Efficacy has been shown to be very good in multiple systems for Lygus, but nymph control only. This is an insect growth regulator.	
Novaluron (Expert 2)		Works best on eggs and early instars. May not be the best fit for the safflower system if the application is delayed to when the oldest bugs are late instars in effort to control as much of the population as possible.	
Sulfoxaflor (Expert 1)	Excellent Lygus and aphid efficacy documented in cotton.		
Sulfoxaflor (Expert 2)	Excellent Lygus and aphid efficacy documented in cotton.		
Efficacy level under different pest pressure	Product effective under high pest pressure	Product effective under moderate pest pressure	Product only effective under low pest pressure
Novaluron (Expert 1)		As an IGR, if properly timed especially on uniformly subimaginal Lygus, the product works very well.	
Novaluron (Expert 2)		Product is best used targeting lygus eggs and/or early instars	
Sulfoxaflor (Expert 1)	Efficacy is very good under a wide range of pest pressures.		
Sulfoxaflor (Expert 2)	Efficacy is very good under a wide range of pest pressures.		
Economics			
Price	Treatment costs lower than other registered products with equivalent efficacy	Treatment costs similar to other registered products with equivalent efficacy	Treatment costs higher than other registered products with equivalent efficacy
Novaluron (Expert 1)		Potentially, cheaper yet effective enough pyrethroids, OPs, or carbamates could be sought out. Lacking this, there are no other compounds with equivalent efficacy. Pyrethroids like bifenthrin, OPs like acephate, and carbamates like oxamyl are all cheaper and might be good uses here in safflower instead of chemistry that is or will be more heavily depended on in other systems.	

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<p>Novaluron (Expert 2)</p>			<p>KEY POINT. The number of highly effective insecticides for lygus bugs is fairly limited. Efficacy, effects on beneficial arthropods, environmental "fit" (primarily air and water impacts) are of utmost importance. Lygus management is critical on high value crops such as strawberries, cotton, vegetables, fruit crops, dry beans, seed alfalfa, etc. Saving the newer, most effective, and "IPM friendly" insecticides for these important crops would seem to be the best strategy to me. Older products — even those that may have reduced efficacy and propensity to flare populations of other pests in other systems — may have better fit for safflower where they can still contribute to IPM without "using up" the most valuable chemistry needed in other crops. A prime example of this is pyrethroid insecticides. There is a level of resistance built-up in lygus bugs. But one application can generally be used per season in safflower and control is adequate. These insecticides are very detrimental to beneficial arthropods which is problematic in cotton and other crops. However in safflower this seems like a good fit.</p>
<p>Sulfoxaflor (Expert 1)</p>		<p>Potentially, cheaper yet effective enough pyrethroids, OPs, or carbamates could be sought out. Lacking this, there are no other compounds with equivalent efficacy. Pyrethroids like bifenthrin, OPs like acephate, and carbamates like oxamyl are all cheaper and might be good uses here in safflower instead of chemistry that is or will be more heavily depended on in other systems.</p>	
<p>Sulfoxaflor (Expert 2)</p>			<p>KEY POINT. The number of highly effective insecticides for lygus bugs is fairly limited. Efficacy, effects on beneficial arthropods, environmental "fit" (primarily air and water impacts) are of utmost importance. Lygus management is critical on high value crops such as strawberries, cotton, vegetables, fruit crops, dry beans, seed alfalfa, etc. Saving the newer, most effective, and "IPM friendly" insecticides for these important crops would seem to be the best strategy to me. Older products — even those that may have reduced efficacy and propensity to flare populations of other pests in other systems — may have better fit for safflower where they can still contribute to IPM without "using up" the most valuable chemistry needed in other crops. A prime example of this is pyrethroid insecticides. There is a level of resistance built-up in lygus bugs. But one application can generally be used per season in safflower and control is adequate. These insecticides are very detrimental to beneficial arthropods which is problematic in cotton and other crops. However in safflower this seems like a good fit.</p>
<p>Value in overall management</p>	<p>Total number of applications needed to achieve economic control decreased</p>	<p>Total number of applications needed to achieve economic control remains constant</p>	<p>Total number of applications needed to achieve economic control increased</p>
<p>Novaluron (Expert 1)</p>		<p>If properly times, only 1 application would be required. This might result in a net increase in no. of sprays to safflower, but a reduction in cotton and adjacent crops.</p>	
<p>Novaluron (Expert 2)</p>		<p>The cotton acreage impacted by safflower is fairly small in most years. For those acres where cotton and safflower are adjacent, this practice could reduce insecticide usage</p>	

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Sulfoxaflor (Expert 1)		If properly timed, only 1 application would be required. This might result in a net increase in no. of sprays to safflower, but a reduction in cotton and adjacent crops.	
Sulfoxaflor (Expert 2)		The cotton acreage impacted by safflower is fairly small in most years. For those acres where cotton and safflower are adjacent, this practice could reduce insecticide usage	
Non-target Effects			
Selectivity - Toxicity to pollinators (honey bees and native pollinators)	Non-toxic to pollinators	Relatively non-toxic to pollinators only if applied during periods when pollinators are not active	Toxic to pollinators
Novaluron (Expert 1)		As an IGR with efficacy on subimaginal insects only and with some selectivity, product is practically non toxic to adult honeybees. Direct exposures to hives can reduce brood.	
Novaluron (Expert 2)		As an IGR with efficacy on subimaginal insects only and with some selectivity, product is practically non toxic to adult honeybees. Direct exposures to hives can reduce brood.	
Sulfoxaflor (Expert 1)		Sulfoxaflor is acutely toxic to honeybees; however, exposure potential is considered low. However, some applications might occur during early bloom in safflower increasing risks to pollinators	
Sulfoxaflor (Expert 2)		Safflower could be blooming when insecticides are needed to manage lygus. Many times the bloom is not totally synchronized in safflower fields. NOTE: Current materials are very toxic to bees in safflower but are applied at night and no problems have been reported with this use pattern.	
Selectivity - Toxicity to beneficial arthropods	Non-toxic to beneficial arthropods	Non-toxic to some beneficial arthropods; toxic to others.	Toxic to many beneficial arthropods; likely to result in secondary pest outbreaks
Novaluron (Expert 1)		Non-toxic to many arthropods; toxic to some.	
Novaluron (Expert 2)		Non-toxic to many arthropods; toxic to some.	
Sulfoxaflor (Expert 1)	Extensive studies in cotton in AZ show this to be relatively non-toxic to beneficial arthropods present in those systems.		
Sulfoxaflor (Expert 2)		Sulfoxaflor may be considered moderate in terms of impact on beneficial arthropods. I think putting it in the "yellow" category is more appropriate.	
Selectivity - Toxicity to other beneficial organisms (for example, earthworms, mycorrhizal fungi)	Non-toxic to other beneficial organisms / low ipmPRIME* earthworm risk score	Non-toxic to some other beneficial organisms; toxic to others / medium ipmPRIME* earthworm risk score	Toxic to many other beneficial organisms / high ipmPRIME* earthworm risk score
Novaluron (Expert 1)	Extremely favorable ipmPRIME profile. Earthworm <0.01		
Novaluron (Expert 2)	Extremely favorable ipmPRIME profile. Earthworm <0.01		
Sulfoxaflor (Expert 1)	Extremely favorable ipmPRIME profile. Earthworm <0.01		
Sulfoxaflor (Expert 2)	Extremely favorable ipmPRIME profile. Earthworm <0.01		

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Attribute	Affirmative Criteria	Intermediate Criteria	Negative Criteria
Selectivity - toxicity to non-target organisms (algae, Daphnia etc)	Non-toxic to non-target organisms / low ipmPRIME* algae and Daphnia risk scores	Non-toxic to some non-target organisms; toxic to others / medium ipmPRIME* algae and Daphnia risk scores	Toxic to many non-target organisms / high ipmPRIME* algae and Daphnia risk scores
Novaluron (Expert 1)	Extremely favorable ipmPRIME profile. Aquatic Algae <0.01; Aquatic Invertebrates around 0.1 (low risk); toxic to Daphnia, but populations recover quickly.		
Novaluron (Expert 2)	Extremely favorable ipmPRIME profile. Aquatic Algae <0.01; Aquatic Invertebrates around 0.1 (low risk); toxic to Daphnia, but populations recover quickly.		
Sulfoxaflor (Expert 1)	Extremely favorable ipmPRIME profile. Aquatic Algae <0.01; Aquatic Invertebrates <0.01		
Sulfoxaflor (Expert 2)	Extremely favorable ipmPRIME profile. Aquatic Algae <0.01; Aquatic Invertebrates <0.01		
Post-application movement as vapor or within plant	Pesticide does not move in plant or movement within plant does not increase risk to pollinators, beneficial arthropods, other beneficial organisms, or non-target organisms	Pesticide movement within plant may increase risk to some pollinators, beneficial arthropods, other beneficial organisms, or non-target organisms	Pesticide movement within plant increases risk to pollinators, beneficial arthropods, other beneficial organisms, or non-target organisms
Novaluron (Expert 1)	Pesticide does not move.		
Novaluron (Expert 2)	Pesticide does not move.		
Sulfoxaflor (Expert 1)	Pesticide movement within plant does not increase risk to non-targets.		
Sulfoxaflor (Expert 2)	Pesticide movement within plant does not increase risk to non-targets.		
Compatible with cultural pest management practices (for example, resistant varieties, crop rotation, sanitation, vegetation management)	Use of pesticide is additive or synergistic with cultural pest management practices	Use of pesticide does not decrease effectiveness or impede implementation of cultural pest management practices	Use of pesticide is not compatible with or decreases the effectiveness of cultural pest management practices
Novaluron (Expert 1)	Use of 1 strategically timed spray to Lygus populations of nearly grown nymphs would prevent migration to other crops.		
Novaluron (Expert 2)	Yes it would be compatible		
Sulfoxaflor (Expert 1)	Use of 1 strategically timed spray to Lygus populations of nearly grown nymphs would prevent migration to other crops.		
Sulfoxaflor (Expert 2)	Yes it would be compatible		
Resistance concerns			
Mode of Action	pesticide has unique MOA for crop/pest combination	one or two other pesticides with the same MOA are available for crop/pest combination	several pesticides with same MOA are available for crop/pest combination
Novaluron (Expert 1)	Unique MOA in safflower with only very limited usage in other crops likely to be grown in systems with safflower.		
Novaluron (Expert 2)		There is some potential for overlap with usage on other crops in the San Joaquin Valley. The most likely candidates for this are dry beans, sweet corn, strawberries, processing tomatoes, peppers, and seed alfalfa.	
Sulfoxaflor (Expert 1)			Unique MOA in safflower; however, this active ingredient is expected to be widely deployed in COTTON and some vegetables as well as alfalfa. Lygus are known to develop resistances and are polyphagous on many Central Valley crops.

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Attribute	Affirmative Criteria	Intermediate Criteria	Negative Criteria
Sulfoxaflor (Expert 2)			Unique MOA in safflower; however, this active ingredient is expected to be widely deployed in COTTON and some vegetables as well as alfalfa. Lygus are known to develop resistances and are polyphagous on many Central Valley crops. NOTE: Increased resistance risk may be overstated. This request is to support 1 very large farming entity that already follows landscape engineering recommendations for concentrating safflower acreage (& the Lygus source). The other high value crops noted are not grown here (except cotton & seed alfalfa). These interfaces are limited in distribution. Only a small number of farms involved here.
Resistance potential	When used according to label instructions, there is low risk of pests developing resistance to the pesticide	When used according to label instructions, there is moderate risk of pests developing resistance to the pesticide	When used according to label instructions, there is significant risk of pests developing resistance to the pesticide
Novaluron (Expert 1)	Resistance is unlikely because active ingredient is only sparingly used elsewhere, plus only nymphs are susceptible to this IGR.		
Novaluron (Expert 2)	The potential is perhaps slightly greater than that stated.		
Sulfoxaflor (Expert 1)			Because an entire generation that supplies the summer cropping system with Lygus is exposed, resistance as a result of multiple exposures in other crops is moderate to high.
Sulfoxaflor (Expert 2)			Because an entire generation that supplies the summer cropping system with Lygus is exposed, resistance as a result of multiple exposures in other crops is moderate to high. See reviewer comments above. And, far fewer acres would be treated in safflower than in all the surrounding cotton and alfalfa where this a.i. is likely to be used. Thus, this additional use may be only a relatively small incremental increase in resistance risk.
Resistance management	Useful in controlling pests which commonly develop resistance to other pesticides	Potentially useful in controlling pests which occasionally develop resistance to other pesticides	Not likely to be useful in resistance management because of existing resistance to the a.i., cross resistance with a.i.s with same mode of action, or pest has never developed resistance previously
Novaluron (Expert 1)	Useful in controlling Lygus which may be prone to resistance to other insecticides.		
Novaluron (Expert 2)	Useful in controlling Lygus which may be prone to resistance to other insecticides.		
Sulfoxaflor (Expert 1)	Useful in controlling Lygus which may be prone to resistance to other insecticides.		
Sulfoxaflor (Expert 2)	Useful in controlling Lygus which may be prone to resistance to other insecticides.		
Number of crops, uses, applications enabled through this use pattern	Pest monophagous (one host) or not mobile	Pest either polyphagous (wide host range) or high mobility	Pest polyphagous (or wide host range) and high mobility
Novaluron (Expert 1)		Very polyphagous and very mobile pest; however, targeted life stage is the nymph which is limited to on host movement.	
Novaluron (Expert 2)		Very polyphagous and very mobile pest; however, targeted life stage is the nymph which is limited to on host movement.	
Sulfoxaflor (Expert 1)			Very polyphagous and very mobile pest.
Sulfoxaflor (Expert 2)			Very polyphagous and very mobile pest.

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Environmental Fate			
Off-site movement - Drift potential	Pesticide formulation or application method has little or no potential for drift (for example, granular formulations or chemigation through drip irrigation lines)	Pesticide application method has some potential for drift (for example boom sprayer applications)	Pesticide application method has potential for drift (for example aerial or airblast sprayer applications)
Novaluron (Expert 1)	No extraordinary drift concerns, despite likely aerial application approach. Fields are large and isolated. Product is relatively non-toxic.		
Novaluron (Expert 2)	No extraordinary drift concerns, despite likely aerial application approach. Fields are large and isolated. Product is relatively non-toxic.		
Sulfoxaflor (Expert 1)	No extraordinary drift concerns, despite likely aerial application approach. Fields are large and isolated. Product is relatively non-toxic.		
Sulfoxaflor (Expert 2)	No extraordinary drift concerns, despite likely aerial application approach. Fields are large and isolated. Product is relatively non-toxic.		
Off-site movement - Run-off potential	Pesticide or pesticide application method result in little or no potential for run-off to surface water	Pesticide or pesticide application method result in some potential for run-off to surface water	Pesticide or pesticide application method result in potential for run-off to surface water
Novaluron (Expert 1)	Safflower production is in arid locations of the central Valley with very little potential for run-off or surface water contamination.		
Novaluron (Expert 2)	The San Joaquin Valley is not a high precipitation area and the time when an application for lygus in safflower might be made (late April through May to early June) does not coincide with when rain typically occurs. Safflower fields are not heavily irrigated (in the best case scenario "winter" rainfall may be enough to produce the crop). Safflower "mines" soil moisture very well reducing the need for supplemental irrigation and potential run-off concerns.		
Sulfoxaflor (Expert 1)	Safflower production is in arid locations of the central Valley with very little potential for run-off or surface water contamination.		
Sulfoxaflor (Expert 2)	The San Joaquin Valley is not a high precipitation area and the time when an application for lygus in safflower might be made (late April through May to early June) does not coincide with when rain typically occurs. Safflower fields are not heavily irrigated (in the best case scenario "winter" rainfall may be enough to produce the crop). Safflower "mines" soil moisture very well reducing the need for supplemental irrigation and potential run-off concerns.		
Off-site movement - Leaching potential	Pesticide or pesticide application method result in little or no potential for leaching to water groundwater	Pesticide or pesticide application method result in some potential for leaching to water groundwater	Pesticide or pesticide application method result in potential for leaching to water groundwater
Novaluron (Expert 1)	Leaching extremely unlikely.		
Novaluron (Expert 2)	Leaching extremely unlikely.		
Sulfoxaflor (Expert 1)	Leaching extremely unlikely.		
Sulfoxaflor (Expert 2)	Leaching extremely unlikely.		
Persistence of parent and breakdown products	Relatively short-half life	Moderate half-life	Long half-life which increases risk of off-site movement or non-target exposure
Novaluron (Expert 1)	In a study that the USEPA found acceptable, novaluron had a half-life of ten to 12 days in clay loam (pH 8.8, 1.7% OC) and sandy loam (pH 5.8, 0.8% OC) and five days in a silt loam soil (pH 7.0, 3.7% OC) all at 20oC.		

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Attribute	Affirmative Criteria	Intermediate Criteria	Negative Criteria
Novaluron (Expert 2)	In a study that the USEPA found acceptable, novaluron had a half-life of ten to 12 days in clay loam (pH 8.8, 1.7% OC) and sandy loam (pH 5.8, 0.8% OC) and five days in a silt loam soil (pH 7.0, 3.7% OC) all at 20oC.		
Sulfoxaflor (Expert 1)	Sulfoxaflor is expected to be non-persistent in soils and exhibits low affinity to soil or sediment particles. In the aerobic soil system, sulfoxaflor degrades into metabolites. Degradates are considered to be highly persistent in soil. Aerobic: Sulfoxaflor = <1day; X-474 = >1,000days; X-540 = 2,808 days Anaerobic: Sulfoxaflor = 113-120 days; X-474 = 1,090-5,270; X-540 = Not available		
Sulfoxaflor (Expert 2)	Sulfoxaflor is expected to be non-persistent in soils and exhibits low affinity to soil or sediment particles. In the aerobic soil system, sulfoxaflor degrades into metabolites. Degradates are considered to be highly persistent in soil. Aerobic: Sulfoxaflor = <1day; X-474 = >1,000days; X-540 = 2,808 days Anaerobic: Sulfoxaflor = 113-120 days; X-474 = 1,090-5,270; X-540 = Not available		
Other IPM factors			
Worker risk	Signal word CAUTION / low ipmPRIME* inhalation risk	Signal word WARNING / medium ipmPRIME* inhalation risk	Signal word DANGER / high ipmPRIME* inhalation risk
Novaluron (Expert 1)	Rimon = Warning; Diamond = Warning. Inhalation risk < 0.01		
Novaluron (Expert 2)	Rimon = Warning; Diamond = Warning. Inhalation risk < 0.01		
Sulfoxaflor (Expert 1)	Closer = Caution; Transform = Danger. Inhalation risk < 0.01		
Sulfoxaflor (Expert 2)	Closer = Caution; Transform = Danger. Inhalation risk < 0.01		
Compatibility with pest monitoring or forecasting	Tight connection between pest population (or forecast) and economic damage threshold	Lack good data on connection between pest population (or forecast) and economic damage threshold	Applications must be made preventatively (and see below)
Novaluron (Expert 1)	Very tight connection to Lygus / safflower phenological model for timing 1 insecticidal spray to prevent migration; Source reduction = Very IPM friendly!		
Novaluron (Expert 2)	I agree although the lygus / safflower phenology model is fairly dated and should be validated under 21st century conditions. NOTE: Safflower growers would have to time spray earlier than they currently consider because of MOA of this compound and is efficacy on smaller instars.		
Sulfoxaflor (Expert 1)	Very tight connection to Lygus / safflower phenological model for timing 1 insecticidal spray to prevent migration; Source reduction = Very IPM friendly!		
Sulfoxaflor (Expert 2)	I agree that there is a very tight connection to Lygus / safflower phenological model for timing 1 insecticidal spray to prevent migration; but the lygus / safflower phenology model is fairly dated and should be validated under 21st century conditions.		

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Preventative applications	Reduce need for additional pest management inputs later		Increase pest management or production inputs
Novaluron (Expert 1)	Reduces potential need for pest management inputs in other crops nearby like cotton where Lygus control and potential yield losses are very costly.		
Novaluron (Expert 2)	I agree that this could reduce the insecticide inputs in nearby crops but lygus are widely produced in/on other crops/hosts such as alfalfa, weeds, understory plants in orchards, etc.		
Sulfoxaflor (Expert 1)	Reduces potential need for pest management inputs in other crops nearby like cotton where Lygus control and potential yield losses are very costly.		
Sulfoxaflor (Expert 2)	This could reduce the insecticide inputs in nearby crops but lygus are widely produced in/on other crops/hosts such as alfalfa, weeds, understory plants in orchards, etc.		