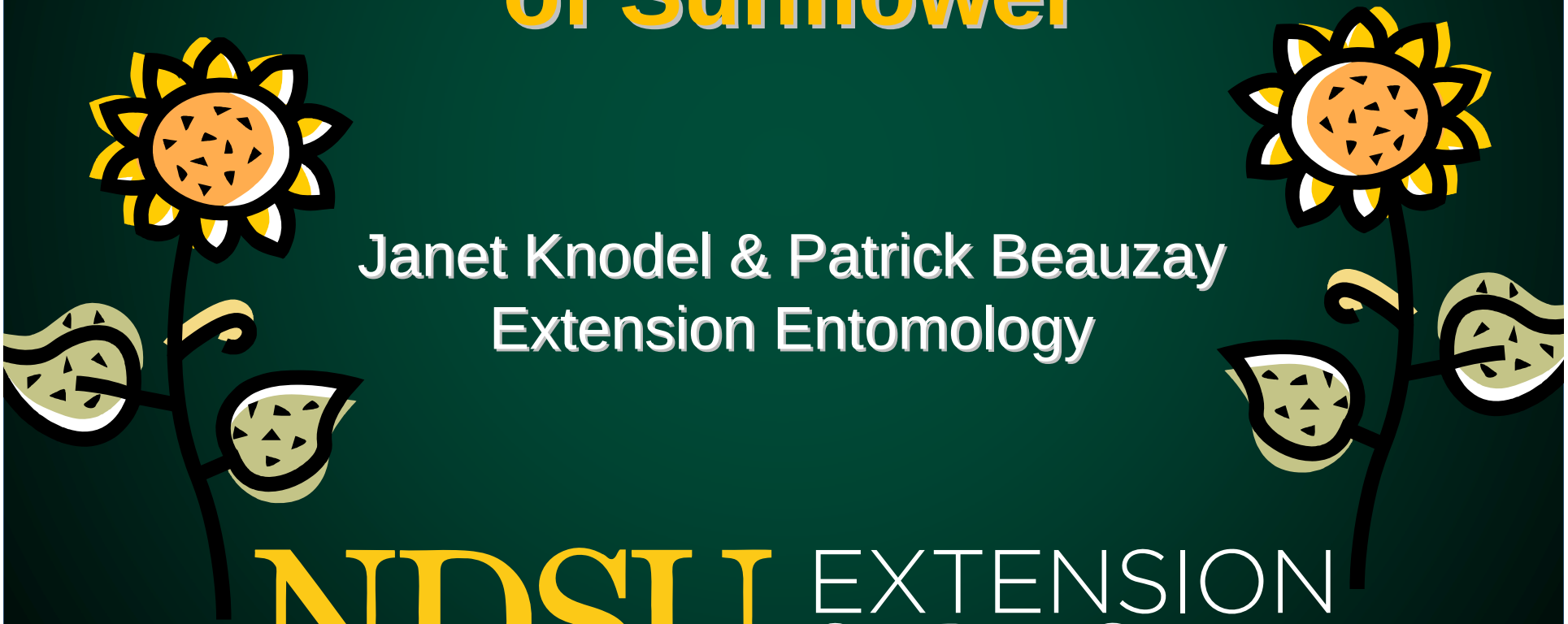
Insecticides for Control of Seed-Feeding Insect Pests of Sunflower



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NDSU EXTENSION SERVICE

Insects Attacking the Sunflower Head & Seeds

Sunflower moth

Lygus bug

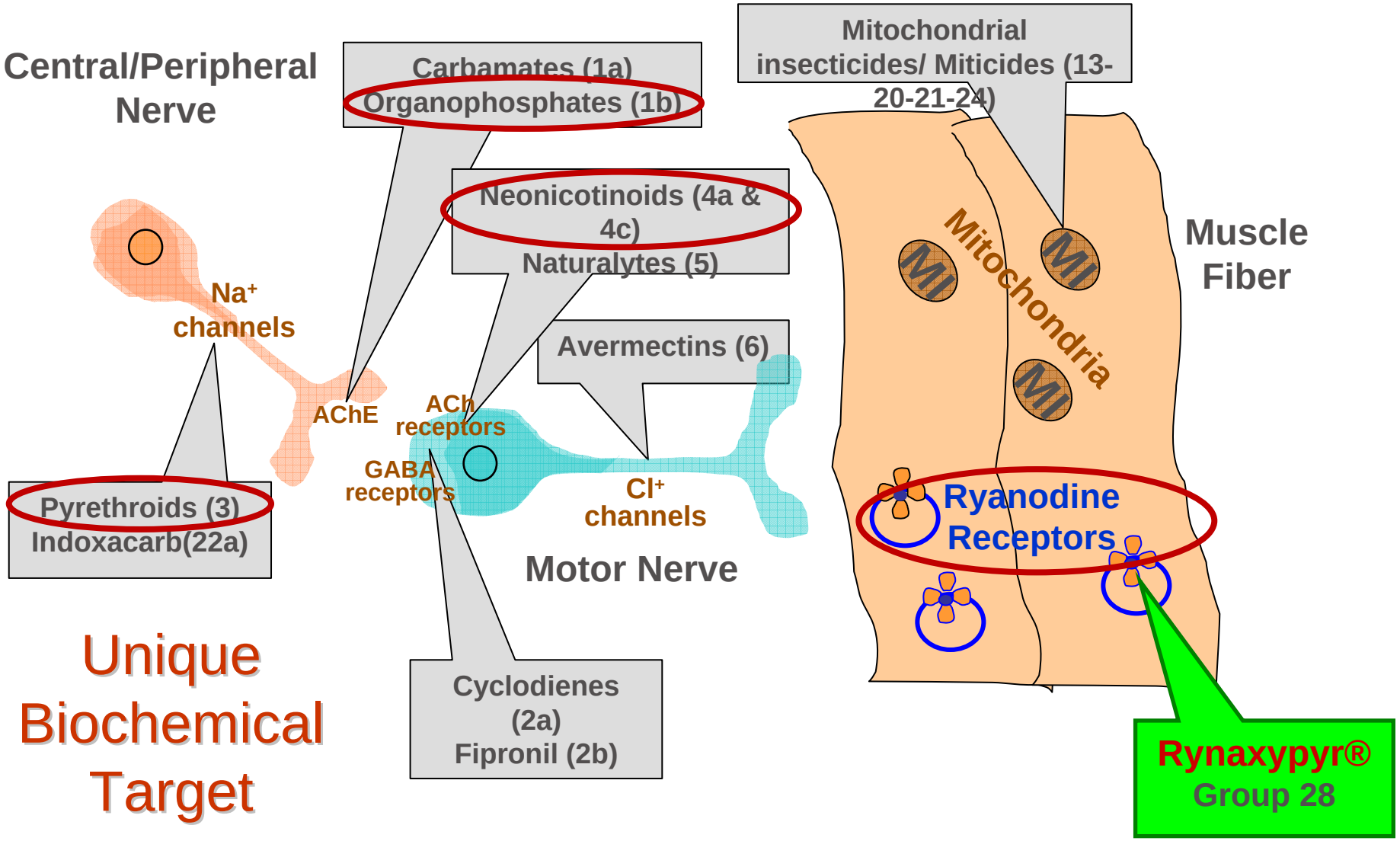
Banded sunflower moth

Red sunflower seed weevil

Sunflower midge

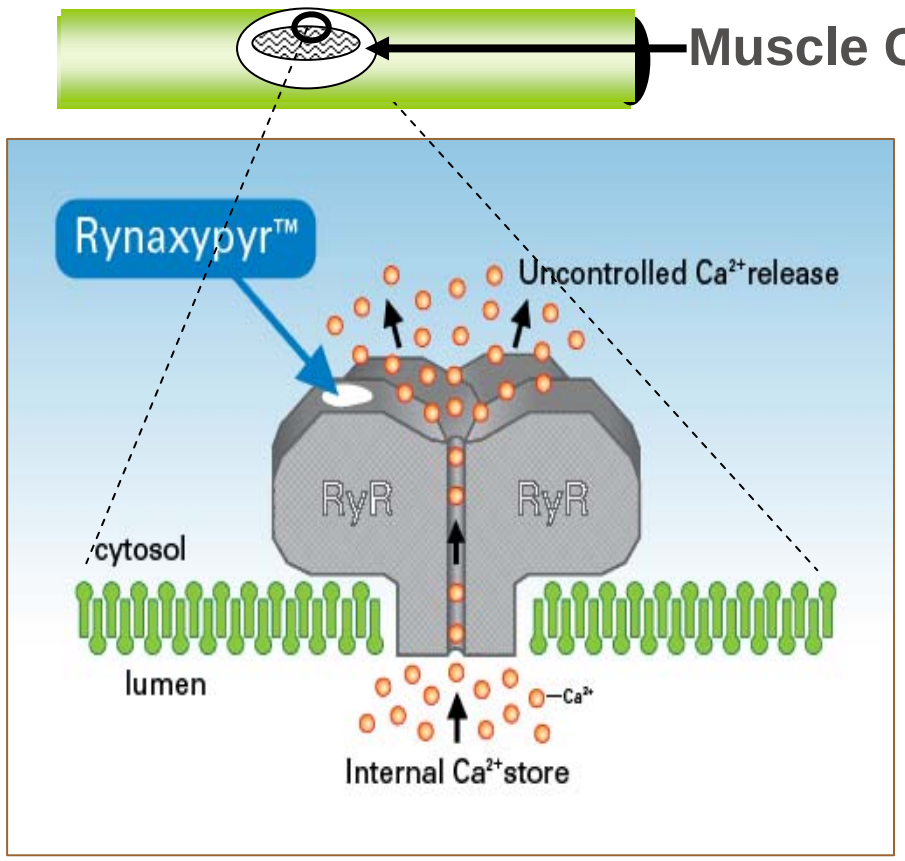
Insecticides Tested

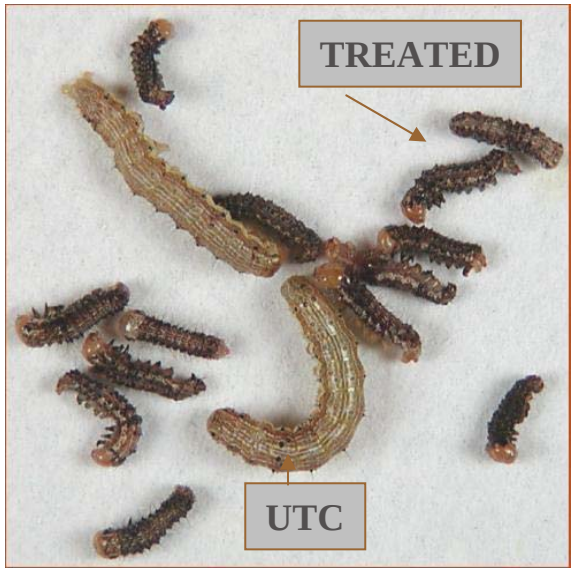
Trade Name	Active Ingredient(s)	IRAC Group	Chemical Class	Registered in Sunflower in ND?
Cobalt Advanced	chlorpyrifos lambda-cyhalothrin	1B 3A	Organophosphates Pyrethroids	Yes
Stallion	chlorpyrifos zeta-cypermethrin	1B 3A	Organophosphates Pyrethroids	Yes
Asana XL	esfenvalerate	3A	Pyrethroids	Yes
Delta Gold	deltamethrin	3A	Pyrethroids	Yes
Mustang Max	zeta-cypermethrin	3A	Pyrethroids	Yes
Warrior II	lambda-cyhalothrin	3A	Pyrethroids	Yes
Endigo ZC	lambda-cyhalothrin thiamethoxam	3A 4A	Pyrethroids Neonicotinoids	No
Fastac	alpha-cypermethrin	3A	Pyrethroids	No
Centric 40WG	thiamethoxam	4A	Neonicotinoids	No
---	sulfoxaflor	4C	Sulfoximines	No
Coragen	chlorantraniliprole	28	Diamides	No
Prevathon SC	chlorantraniliprole	28	Diamides	No



Rynaxypyr® (IRAC MOA Group 28) acts upon a biochemical target different from all other commercial insecticides.

DuPont™ Rynaxypyr® - Novel Mode of Action Activates Insect Ryanodine Receptors





- Muscle paralysis
- Rapid feeding cessation
- Death within ~ 72 hours

Insects Controlled by Rynaxypyr®

Lepidoptera

- **Noctuidae:** Heliothines (bollworms,budworms); *Earias* spp. (bollworms); *Spodoptera* spp. (armyworms); A*grotis* (**cutworms**); *Pseudoplusia; Trichoplusia* (**loopers);** *A. argillaceae*, A. gemmatalis (leaf worms); others.
- **Tortricidae:** *Argytotaenia, Choristoneura* (leafrollers); *Carposina, Cydia, Grapholita* (fruit moths), *Lobesia* (berry moths); among others.
- **Crambidae, Pyralidae:** *Chilo* (**stem borers**); *Ostrinia* (corn borers); *Hellula* (**cabbage worms**); *Lerodea* (leaf folders); *Leucinodes, Neoleucinodes* (fruit borers), *Desmia* funeralis (snout moths), Crocidolomia (cluster caterpilar); Maruca (pod borers); others.
- **Gelechiidae, Pieridae, Plutellidae:** *Anarsia* (twig borers); *Tuta, Keiferia* (pinworms); *Pieris* (whites, sulfur); *P. xyllostella* (**diamondback moth**); others.
- **Gracillariidae, Lyonetidae:** *Phyllonorycter*, *Phyllocnistis, Leucoptera* (leafminers); others.
- **Others (ex. Zygaenidae):** *Harrisina americana* (leaf skeletinizer)

Others

- Colorado potato beetle
- Grasshoppers (nymphs)
- Rice water weevil
- ** Pepper weevil
- ** Serpentine vegetable leafminer
- ** Whiteflies

** ***Best performance when applied via soil***

Ovi-Larvicidal against *Anticarsia gemmatalis* Activity

Anticarsia gemmatalis (Velvetbean caterpillar) eggs sprayed with Rynaxypyr® 20 SC at 1 g ai/ 100 L

Intoxicated Neonate attempting to get out of the egg

Intoxicated Neonate does not successfully hatch or dies immediately after hatching

Photos: M. Lima, Paulínia, Brazil

Translaminar Activity

Translaminar activity of Coragen® against *Plutella xyllostella* larvae on cabbage

Translaminarly Active

Coragen® at 50 ppm + 0.5% MSO provided 94% translaminar activity

Untreated Control

Water + 0.5% Methylated Seed Oil

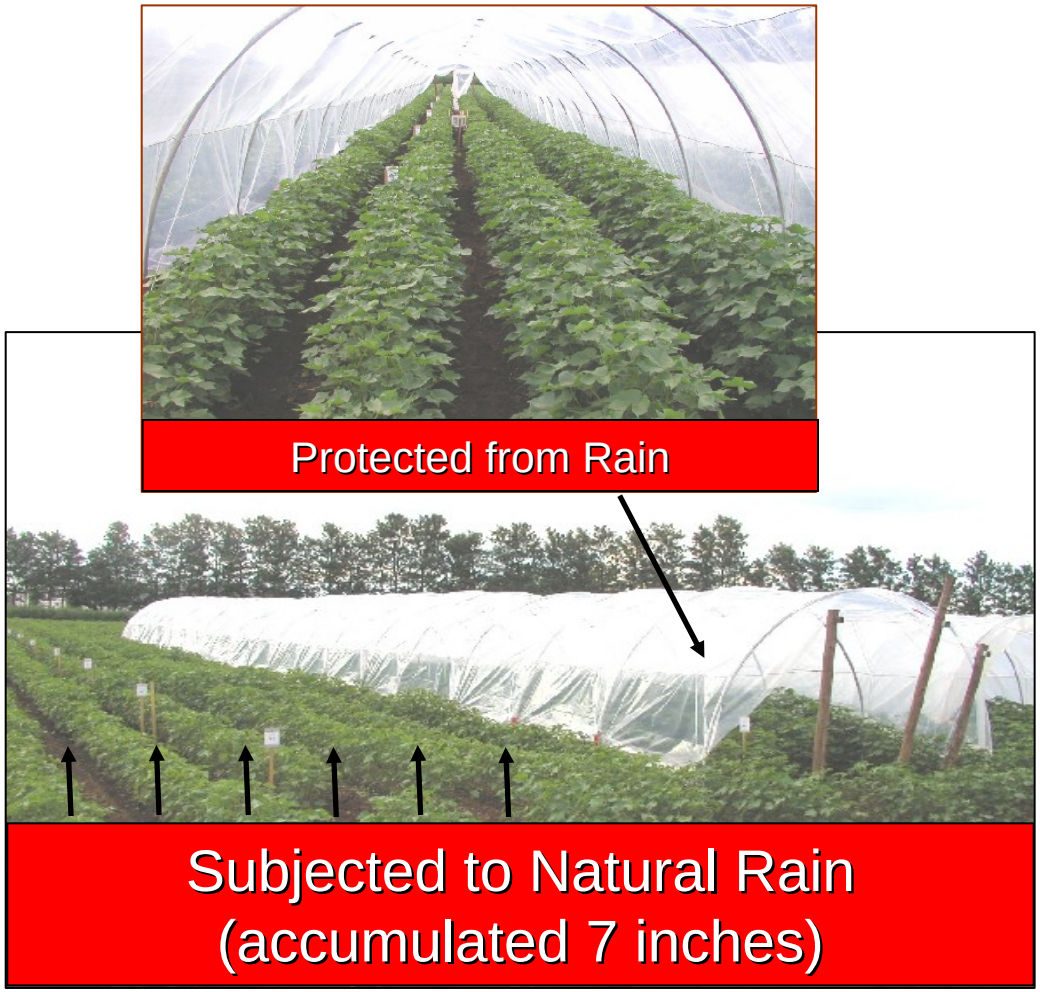
Rynaxypyr® is highly translaminar.

Photos: R. Kaczmarczyk; Data: D. Clagg & J. Barry - Delaware, USA

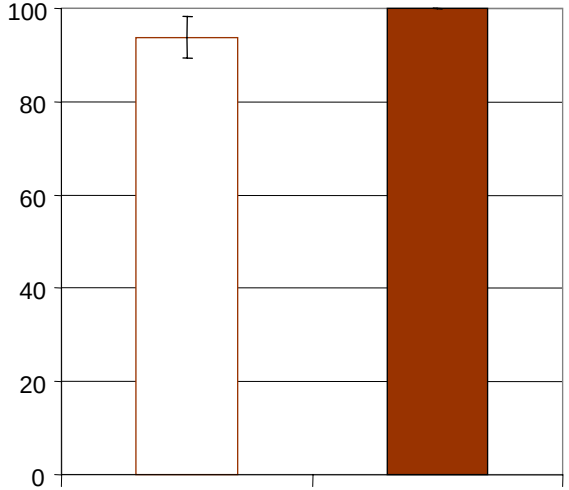
DuPont™ Coragen® - Cotton

Rainfastness and Residual Activity

28 DAA1



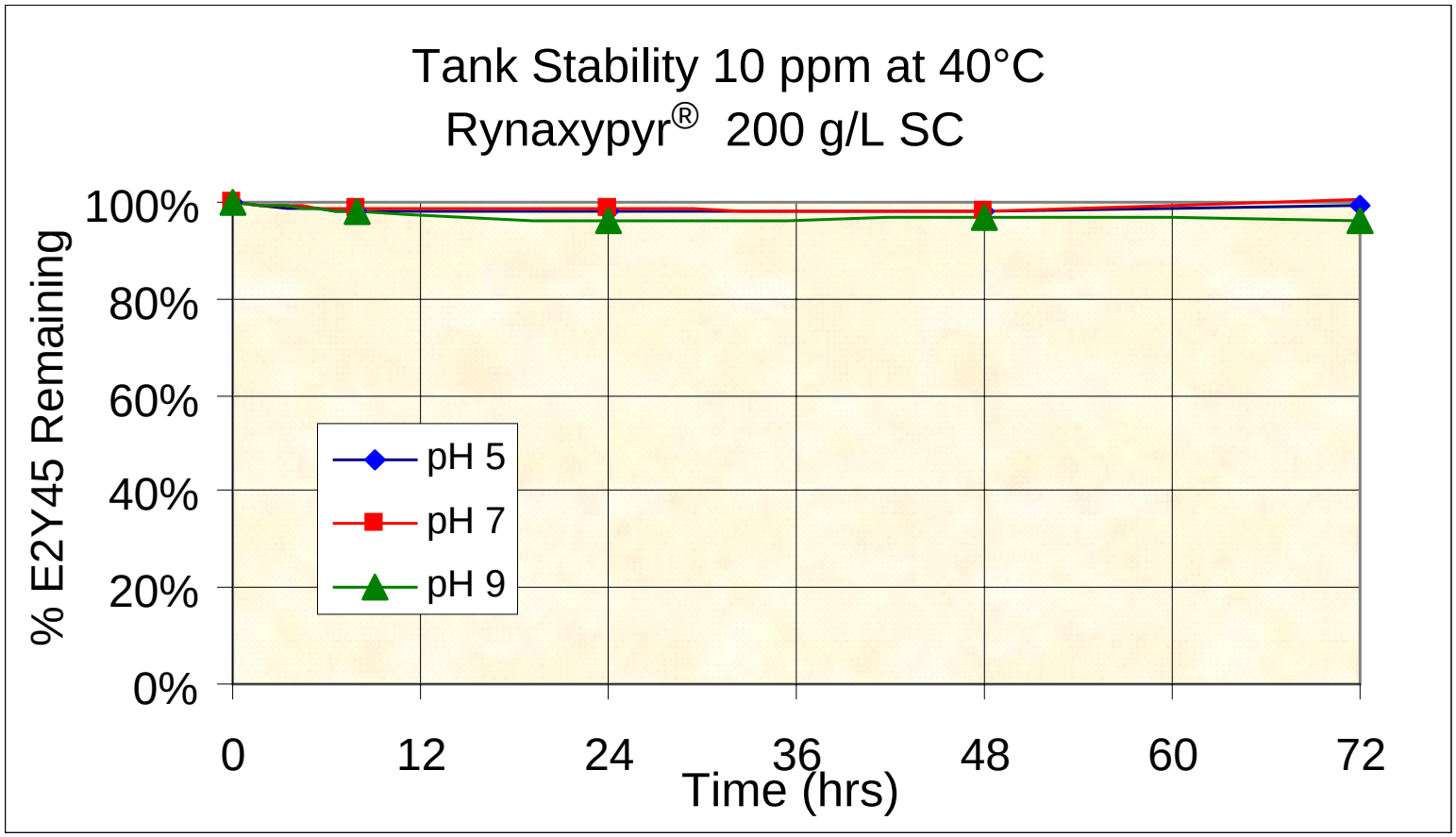
% Mortality of 3rd instar
S. frugiperda larvae



Rynaxypyr® 0.027 Lb ai/A

Heavy rain did not significantly reduce efficacy, even after 28 days

DuPont™ Coragen®- Tank Stability Results



Coragen® proved to be stable, even under the most extreme conditions (i.e., 10 ppm; pH = 9; T = 40°C) for 72 hours.

Selectivity to Beneficial Insects

Low to no impact on pollinators, parasitoids, and predators

Rynaxypyr® has excellent selectivity to Beneficial Arthropods

Evaluation of Rynaxypyr® on Key Predators

GROUP	ORDER	FAMILY	SPECIES	RESULT
Predators	Neuroptera	Chrysopidae	*Chrysoperla carnea*	●
	Lacewings		*Mallada signatus*	●
	Coleoptera	Coccinellidae	*Hippodamia convergens*	●
	Ladybird beetles		*Hippodamia variegatta*	●
			Harmonia axyridis	●
	Hemiptera	Nabidae	*Nabis kinbergii*	●
	Predatory bugs	Anthrocoridae	*Orius insidiosus*	●
			Anthocoris nemoralis	●
		Miridae	*Deraeocoris brevis*	●
		Lygaeidae	*Geocoris punctipes*	●
	Acari	Phytoseiidae	*Amblyseius herbicolus*	●
	Predatory mites		*Amblyseius andersoni*	●
			*Kampimodromus aberrans*	●
			Euseius citrifolius	●
			Iphiseiodes zulugai	●
			Typhlodromus occidentalis	●
			Typhlodromus pyri	●

● **no impact, (0-30% mortality).**
Rating according to IOBC/ WPRS Working Group, Hassan et al. 1988.

Rynaxypyr® has excellent selectivity to Beneficial Arthropod & Pollinators

Evaluation of Rynaxypyr® on Key Parasitoids and Pollinators

GROUP	ORDER	FAMILY	SPECIES	RESULT
Parasitoids 	**Hymenoptera** **Parasitic wasps**	**Trichogrammatidae**	*Trichogramma pretiosum*	●
			Trichogramma chilonis	●
		Braconidae	*Aphidius rhopalosiphi*	●
			Bracon hebetor	●
			Dolichogenidea tasmanica	●
		Encyrtidae	*Ageniaspis citricola*	●
		Aphelinidae	*Aphelinus mali*	●
	**Hymenoptera** **Honey bees and Bumble bees**	**Apidae**	*Apis mellifera*	●
			Bombus terrestris	●

● **no impact,** (0-30% mortality). Rating according to IOBC/ WPRS Working Group, Hassan et al. 1988.

Tank Mixing Compatability

Active Ingredient	Active Ingredient	Active Ingredient
Acetamiprid	Dinocap	Methomyl
Alphamethrin	Dithianon	Methoxyfenozide
Azinphos-methyl	Dofentezine	Metiram
Azoxystrobin	Esfenvalerate	Myclobutanil
Bifenthrin	Famoxadone + Cymoxanil	Oxamyl
Boscalid	Famoxadone + Fosethyl-al	Penconazole
Bupirimate	Famoxadone + Mancozeb	Phosmet
Buprofezin	Famoxate + Cymoxanil + Folpet	Picoxystrobin
Captan	Fenoxicarb	Propiconazole
Carbaryl	Fludioxinil + Cyprodinil	Proquinazid
Chlorothalonil	Flusilazole	Pyridaben
Chlorpyrifos	Fosetyl-al + Folpel + Cymoxanil	Pyrimetanil
Ciproconazole	Imidacloprid	Quinoxyfen
Copper-hydroxide	Indoxacarb	Spinosad
Cyfluthrin	Iprodione	Sulfur
Cymoxanil + Copper Oxychloride	Kresoxim-methyl	Tebuconazole
Cymoxanil + Mancozeb	Lambda- cyhalothrin	Thiacloprid
Cyprodinil	Malathion	Thiamethoxam
Deltamethrin	Mancozeb	Trifloxystrobin
Dichlofluanid	Metalaxyl + mancozeb	Ziram
Difenconazole		

Coragen™ is compatible with all Inseciticides, Fungicides and Fertilizers tested to date.

Do a jar test before mixing any chemical. Follow label instructions.

To date: > 65 partners tested in 2-way mixtures

Comparative Acute Oral and Dermal Toxicities of Coragen® vs. Other Insecticides:

Product	AI	Acute Oral LD_{50} mg/kg(m/f)	Acute Dermal LD_{50} mg/kg(m/f)	EPA Toxicity Category - Signal Word
Bts	*B. thuringiensis*	> 4000	nontoxic	IV - Caution
Coragen®	Rynaxypyr®	> 5000	> 5000	IV – (None!!)
Decis®	deltamethrin	395	>2000	I - Danger
Lorsban ®	chlorpyrifos	> 300		
Malathion ®	Lambda-cyhalothrin	92.91		

LD_{50} = Lethal Dose (mg/kg) to kill 50% of population
M/F = Male/Female rats

Minimum PPE and REI requirements

Consequence of favorable toxicological profile:

Regulatory agencies around the world approved PPE and REI requirements that are favorable to our customers

Example from Canadian MSDS/label:

- Coragen® Long-sleeved shirt
  - Long pants
  - Socks and shoes
- Short re-entry intervals – 12 h
- Short Pre-harvest intervals – 1 day

2011-12 Insecticide Efficacy Evaluation

- Insecticide timing:
  - R5.1 (10% of disk flowers open)
  - Applied August 5, 2011
  - Applied July 14, 2012
- Modes of Actions:
  - Pyrethroid (Group 3a) – esfenvalerate
    - Asana XL at 9.6 fl oz per acre
  - Chlorantraniliprole (Group 28) - DuPont
    - Prevathon™ (Rynaxypyr®) at 10 & 14 fl oz per acre

Banded sunflower moth

Red sunflower seed weevil

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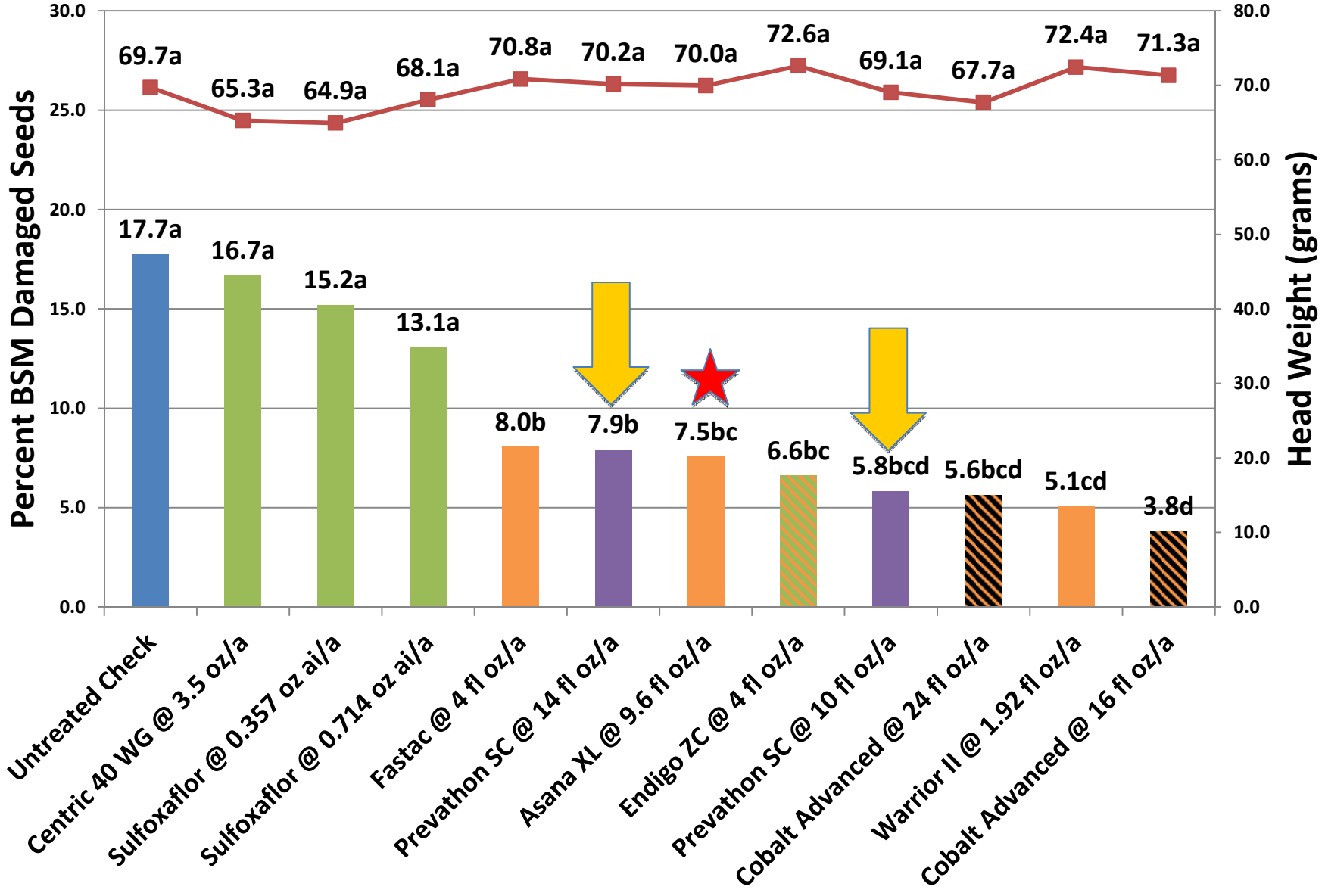
Treatment Means for BSM Damaged Seed and Head Weight at Mapleton, 2011



Treatment Means for BSM Damaged Seed and Head Weight at Mapleton, 2012

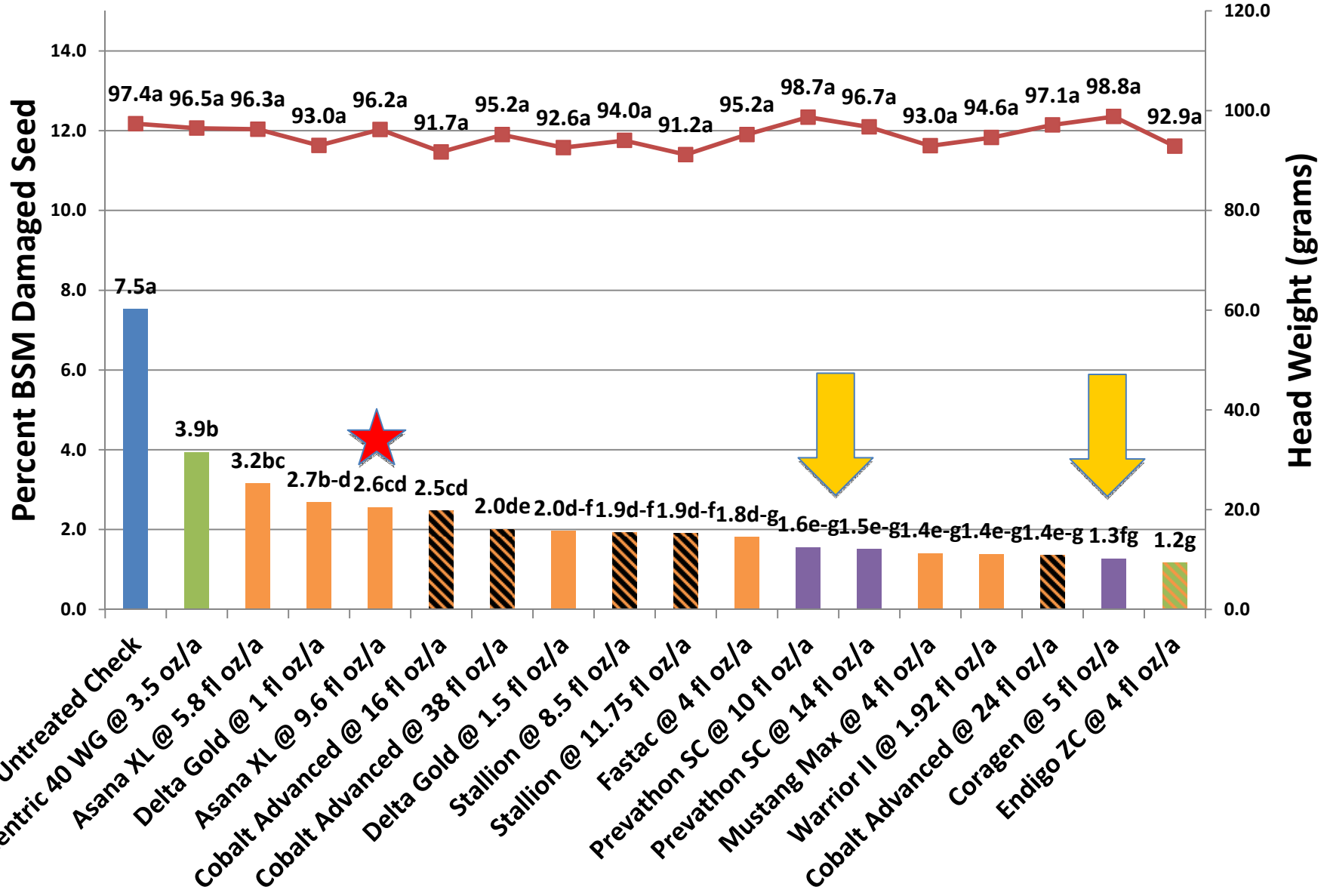
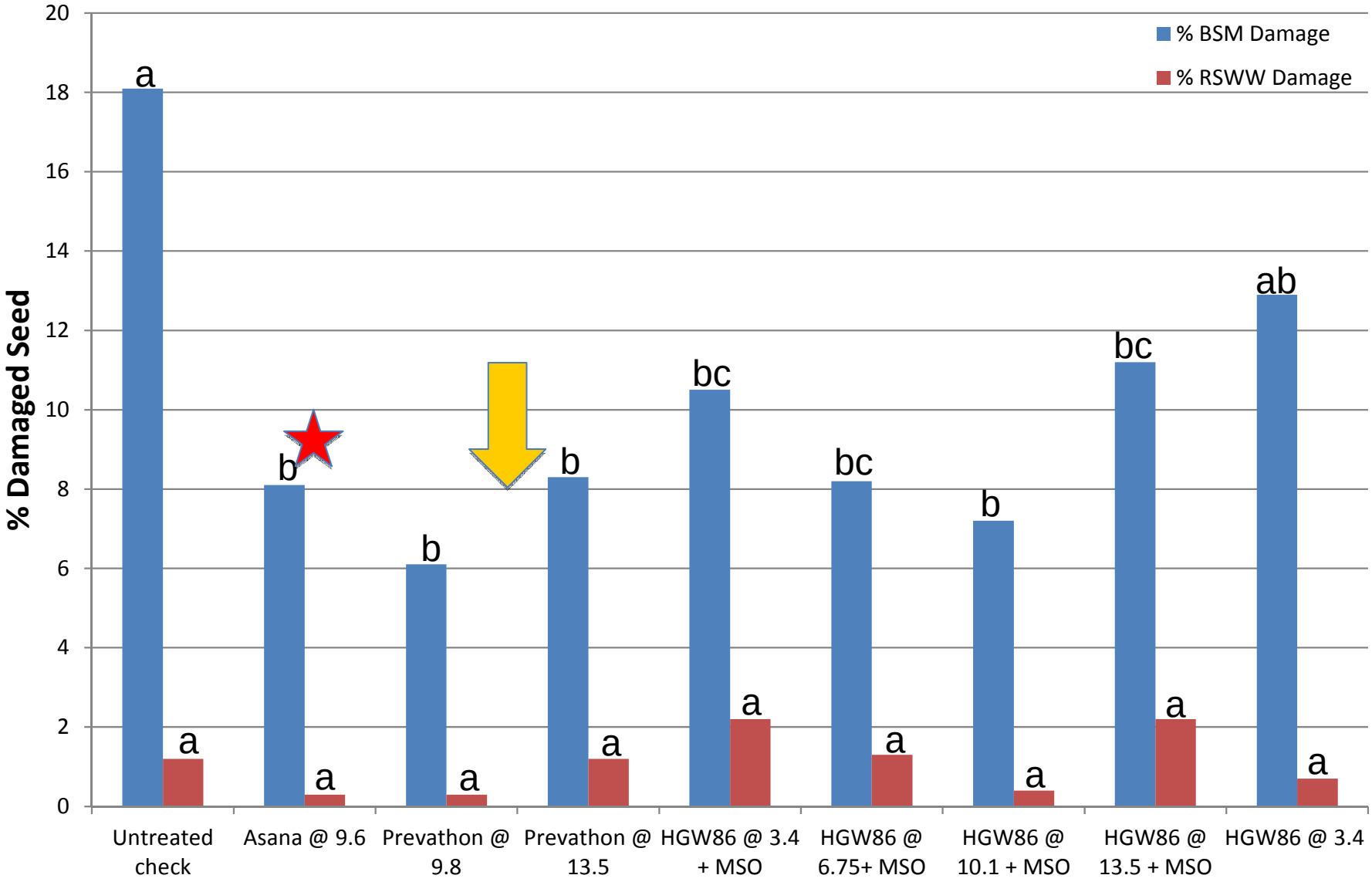


Figure 2. 2011 Insecticide Trial - Percent Damaged Seed for Banded Sunflower Moth (BSM) and Red Sunflower Seed Weevil (RSSW)



Fisher's LSD; $P \leq 0.05$

Sunflower Head Moth in Sunflower Trial CEH-09-063, 2009, KSU

Treatment (2 Applications)	Rate (g ai/ha)	% Control (Tukeys)	Average # of Larvae per 4 half heads (Tukeys)
		10 DAA	10 DAA
Untreated Check	---	**0% f**	**116 a**
cyantraniliprole	25	**98% a**	**2.50 h**
cyantraniliprole	50	**95% b**	**6.00 e**
cyantraniliprole	75	**95% b**	**5.50 f**
cyantraniliprole	100	**84% d**	**18.70 c**
cyantraniliprole + MSO	50 + 0.5	**89% c**	**12.20 d**
chlorantraniliprole	75	**98% a**	**2.70 g**
esfenvalerate	55	**68% e**	**37.00 b**

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Summary

- Rynaxypyr® new mode of action
  - Ryanodine receptor activator (IRAC Group 28)
- Active against a broad range of chewing insects
  - Efficacy comparable or even better than other sunflower insecticides
- Longer residual than other insecticides registered in sunflowers
- Favorable toxicology and ecotox
  - Applicator, bees, beneficial insects, environment
- Available in 2013 field season

Thank you!


Keith Johnson & Saghir Alam, Dupont
NDSU EXTENSION SERVICE
NDSU EXTENSION SERVICE Entomology