Technical Report

TR19-10 November, 2019

Agricultural Experiment Station

College of
Agricultural Sciences

Department of
Bioagricultural Sciences and
Pest Management

2016 Colorado Field Crop Insect Management Research and Demonstration Trials

2016 Colorado Field Crop Insect Management Research and Demonstration Trials[1]

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[1]Mention of a trademark or proprietary product does not constitute endorsement by the Colorado Agricultural Experiment Station.

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CONTROL OF ALFALFA INSECTS IN ALFALFA WITH HAND-APPLIED INSECTICIDES, ARDEC, FORT COLLINS, CO, 2016

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CONTROL OF ALFALFA INSECTS IN ALFALFA WITH HAND-APPLIED INSECTICIDES, ARDEC, FORT COLLINS, CO, 2016: Early treatments were applied on 4 April 2016 with a 'rickshaw-type' CO_2 powered sprayer calibrated to apply 20 gal/acre at 3 mph and 30 psi through six XR8002VS nozzles mounted on a 10.0 ft boom. Early treatments were made approximately when army cutworm treatments are applied in the region. This was done to determine the effect of army cutworm treatment in alfalfa on subsequent alfalfa weevil larval densities. All other treatments were applied in the same manner on 12 May 2016. Conditions for the early treatments were clear skies with 5 to 9 mph wind from the southeast and 68°F, and for the later treatments, clear, calm and 65°F. No precipitation was recorded during the 24 h period following either treatment date. Plots were 10.0 ft by 25.0 ft and arranged in six replicates of a randomized, complete block design. The untreated control and Warrior II, 1.92 oz./acre, plots were replicated 12 times for a more accurate comparison of treatment effects on yield (insect counts from six reps of each treatment were included in the analyses described below). The alfalfa was 6 inches in height at the time of early treatments and 12 inches at the time of the later treatments.

Treatments were evaluated by taking ten 180° sweeps per plot with a standard 15 inch diameter insect net 4, 14, 21 and 27 days after the later treatments (DAT). Alfalfa weevil larvae, alfalfa weevil adults and pea aphids were counted. A pretreatment sample was taken on 4 May 2016 by taking 60, 180° sweeps across the experimental area. A total of 92 alfalfa weevil larvae, 3 alfalfa weevil adults, and 15 pea aphids was collected in this sample. Counts were transformed by the square root + 0.5 method for nonadditivity. Transformed counts were subjected to analysis of variance and mean separation by Tukey's Honestly Significant Difference (HSD) procedure (α=0.05). Original means are presented in Tables 1-3. Yields were measured on 10 June 2016 by hand harvesting a 0.5 m^2 area per plot. Samples were weighed wet and dry and converted to lbs of dry hay per acre prior to comparing treated and untreated yields using analysis of variance.

Alfalfa weevil larval densities were substantially lower than those observed in 2015, averaging 64.4 and 8.6 larvae per sweep 14 DAT in 2015 and 2016, respectively. Pea aphid densities were higher than those observed in 2015, averaging 0.2 and 3.8 aphids per sweep at 14 DAT in 2015 and 2016, respectively. All treatments had fewer alfalfa weevil days than the untreated control (Table1). Pea aphid days were similar for all treatments except Mustang Max 0.8EC, 4 oz + Steward, 4 oz and Steward EC, 11.3 oz, which had more (Table 3). No phytotoxicity was observed with any treatment. Yields were 9.5% lower in the untreated plots (df=11,23; F=5.82; p>F=0.0344). Yield reductions have been measured measured at ARDEC since 1996 and in 11 of the 20 years the differences have been statistically significant (α=0.10). Losses in years with statistical differences have averaged 8.9%, with a range of -14.3 to 23.9%.

Field History

Pests:	Alfalfa weevil, *Hypera postica* (Gyllenhal) Pea aphid, *Acyrthosiphon pisum* (Harris)
Cultivar:	Dekalb DKA41-18RR
Plant Stand:	Good
Irrigation:	Furrow
Crop History:	Alfalfa since August 2011
Herbicide:	Roundup Power Max, 1qt and Helfire, 0.09 gallon on 14 April 2016
Insecticide:	None prior to experiment
Fertilization:	None
Soil Type:	Sandy clay loam
Location:	Agricultural Research, Development and Education Center (ARDEC), 4616 North Frontage Road, Fort Collins, CO, 80524 (SW corner of Bee Circle) (N40.66880, W104.99969)

Table 1. Control of alfalfa weevil larvae with hand-applied insecticides, ARDEC, Fort Collins, CO. 2016.

PRODUCT, FL OZ/ACRE	ALFALFA WEEVIL LARVAE PER 180° SWEEP ± SE[1] 4 DAT	14 DAT	21 DAT	27 DAT	TOTAL WEEVIL DAYS[2] ± SE	% REDUCTION IN WEEVIL DAYS
Mustang Max 0.8EC, 4 oz + Steward, 4 oz	1.8 ± 0.4 BC	2.5 ± 1.4 CD	8.1 ± 1.7 EF	5.5 ± 0.7 I	120.9 ± 16.8 G	74
Steward EC, 11.3 oz	1.7 ± 0.2 BC	1.9 ± 0.3 CD	8.8 ± 1.4 DEF	8.6 ± 1.0 EFGHI	121.6 ± 13.1 G	74
Cobalt Advanced, 19 oz**	0.8 ± 0.4 C	1.4 ± 0.2 D	5.7 ± 1.3 F	17.7 ± 2.3 ABCDEF	121.6 ± 13.0 G	74
Stallion 3EC, 11.75 oz	1.2 ± 0.2 BC	2.0 ± 0.6 CD	9.0 ± 2.1 DEF	7.9 ± 0.9 GHI	123.0 ± 16.5 G	74
Cobalt Advanced, 24 oz	1.8 ± 0.2 BC	1.4 ± 0.3 D	10.4 ± 2.4 CDEF	7.9 ± 1.0 HI	126.2 ± 15.8 G	73
Beseige 1.25 ZC, 9 oz	1.3 ± 0.2 BC	1.8 ± 0.3 CD	10.0 ± 1.6 CDEF	8.2 ± 1.1 FGHI	129.8 ± 13.6 FG	72
Endigo ZCX 2.71 ZC, 4 oz	2.3 ± 0.5 ABC	1.8 ± 0.4 CD	8.6 ± 0.9 DEF	9.3 ± 1.0 DEFGHI	135.0 ± 5.6 EFG	71
Warrior II, 1.92 oz	1.2 ± 0.3 BC	2.6 ± 0.5 BCD	11.0 ± 2.2 CDEF	9.6 ± 1.2 DEFGHI	147.2 ± 19.1 DEFG	68
Warrior II, 1.92 oz**	0.7 ± 0.1 C	2.2 ± 0.4 CD	12.4 ± 1.6 BCDEF	11.6 ± 3.3 DEFGHI	151.9 ± 16.4 DEFG	67
Baythroid XL, 2.8 oz	2.1 ± 0.4 ABC	2.9 ± 0.8 BCD	12.4 ± 2.3 BCDEF	13.2 ± 1.7 CDEFGHI	179.7 ± 26.3 CDEFG	62
Lorsban Advanced, 32 oz	1.6 ± 0.5 BC	2.7 ± 0.5 BCD	11.5 ± 0.8 BCDEF	18.1 ± 3.0 ABCDE	179.8 ± 11.5 CDEFG	61
Mustang Max 0.8EC, 4 oz	2.5 ± 1.0 ABC	3.9 ± 0.1 ABCD	14.1 ± 1.5 BCDE	9.1 ± 1.0 EFGHI	192.6 ± 13.8 CDEFG	59
Baythroid XL, 2.8 oz**	1.6 ± 0.4 BC	3.8 ± 0.9 ABCD	13.8 ± 2.6 BCDE	14.9 ± 2.9 BCDEFGH	196.2 ± 26.7 CDEFG	58
Stallion 3EC, 11.75 oz early + Mustang Max 0.8EC 4 oz at conventional timing	1.8 ± 0.3 ABC	4.8 ± 0.6 ABC	14.0 ± 2.2 BCDE	17.2 ± 2.1 ABCDEFG	215.6 ± 18.4 BCDEF	54
Mustang Max 0.8EC, 4 oz**	1.6 ± 0.2 BC	4.3 ± 0.6 ABCD	15.2 ± 1.4 BCDE	17.8 ± 1.4 ABCDE	218.2 ± 8.9 BCDE	53
Warrior II, 1.92 oz*	2.4 ± 0.4 ABC	3.8 ± 0.6 ABCD	16.9 ± 2.2 BCD	17.8 ± 1.8 ABCDE	233.9 ± 20.1 BCD	50
Mustang Max 0.8EC, 4 oz*	3.0 ± 1.0 ABC	5.1 ± 0.1 ABC	15.6 ± 2.8 BCDE	19.2 ± 2.8 ABCD	249.1 ± 32.0 BC	47
Cobalt Advanced, 19 oz*	2.1 ± 0.3 ABC	5.0 ± 0.8 ABC	18.3 ± 3.4 BC	26.0 ± 2.3 AB	275.7 ± 23.2 BC	41
Baythroid XL, 2.8 oz*	3.3 ± 0.4 AB	6.2 ± 0.6 AB	20.4 ± 2.6 B	23.8 ± 2.6 ABC	307.4 ± 25.5 B	34
Untreated control	4.8 ± 1.0 A	8.6 ± 0.3 A	36.1 ± 5.4 A	30.1 ± 5.4 A	466.9 ± 63.5 A	0
F value	3.94	6.39	10.95	11.11	17.39	
p>F	0.0000	0.0000	0.0000	0.0000	0.0000	

[1]SE, standard error of the mean. Means in the same column followed by the same letter(s) are not statistically different, Tukey's HSD (∝=0.05).

[2]Calculated by the method of Ruppel (Journal of Economic Entomology 76: 375-7, 1983). The table is sorted by the means in this column.

*Early treatment date, **Early treatment date, repeated at conventional timing.

Table 2. Control of alfalfa weevil adults with hand-applied insecticides, ARDEC, Fort Collins, CO. 2016.

PRODUCT, FL OZ/ACRE	ALFALFA WEEVIL ADULTS PER 180° SWEEP ± SE[1] 21 DAT	27 DAT
Lorsban Advanced 32 oz	0.0 ± 0.0	0.1 ± 0.1
Stallion 3EC, 11.75 oz early + Mustang Max 0.8EC 4 oz at conventional timing	0.1 ± 0.0	0.2 ± 0.1
Steward EC, 11.3 oz	0.1 ± 0.0	0.2 ± 0.1
Baythroid XL, 2.8 oz**	0.0 ± 0.0	0.2 ± 0.1
Baythroid XL, 2.8 oz*	0.1 ± 0.0	0.2 ± 0.1
Cobalt Advanced, 19 oz**	0.0 ± 0.0	0.2 ± 0.1
Untreated control	0.1 ± 0.0	0.2 ± 0.1
Mustang Max 0.8EC, 4 oz	0.0 ± 0.0	0.2 ± 0.1
Mustang Max 0.8EC, 4 oz*	0.0 ± 0.0	0.2 ± 0.1
Cobalt Advanced, 19 oz*	0.0 ± 0.0	0.3 ± 0.1
Stallion 3EC, 11.75 oz	0.1 ± 0.0	0.3 ± 0.1
Warrior II, 1.92 oz*	0.1 ± 0.0	0.3 ± 0.1
Warrior II, 1.92 oz**	0.1 ± 0.0	0.3 ± 0.1
Cobalt Advanced, 24 oz	0.1 ± 0.0	0.3 ± 0.1
Mustang Max 0.8EC, 4 oz + Steward, 4 oz	0.1 ± 0.1	0.3 ± 0.1
Warrior II, 1.92 oz	0.1 ± 0.0	0.3 ± 0.1
Baythroid XL, 2.8 oz	0.1 ± 0.0	0.3 ± 0.1
Mustang Max 0.8EC, 4 oz**	0.0 ± 0.0	0.4 ± 0.1
Beseige 1.25 ZC, 9 oz	0.1 ± 0.0	0.4 ± 0.1
Endigo ZCX 2.71 ZC, 4 oz	0.0 ± 0.0	0.4 ± 0.1
F value	1.18	1.02
p>F	0.2912	0.4456

[1]SE, standard error of the mean.

*Early treatment date, **Early treatment date, repeated at conventional timing.

Table 3. Control of pea aphids with hand-applied insecticides, ARDEC, Fort Collins, CO. 2016.

PRODUCT, FL OZ/ACRE	PEA APHIDS PER 180° SWEEP ± SE[1] 4 DAT	14 DAT	21 DAT	27 DAT	TOTAL APHID DAYS[2] ± SE
Lorsban Advanced 32 oz	0.3 ± 0.3 BC	0.8 ± 0.2 C	8.1 ± 1.5 BC	22.2 ± 2.7 AB	128.1 ± 9.2 C
Cobalt Advanced, 24 oz	0.2 ± 0.1 BC	0.4 ± 0.1 C	6.9 ± 1.8 C	29.1 ± 5.3 A	136.9 ± 13.7 C
Untreated control	2.4 ± 0.8 A	1.6 ± 0.3 ABC	11.9 ± 2.7 ABC	11.2 ± 2.2 B	138.2 ± 20.1 C
Warrior II, 1.92 oz	0.2 ± 0.2 BC	0.5 ± 0.2 C	9.1 ± 1.8 ABC	24.8 ± 4.9 AB	139.4 ± 26.2 C
Cobalt Advanced, 19 oz**	0.0 ± 0.0 C	0.6 ± 0.1 C	10.0 ± 1.2 ABC	24.9 ± 4.2 AB	144.8 ± 18.5 BC
Cobalt Advanced, 19 oz*	0.3 ± 0.1 BC	1.7 ± 0.6 ABC	10.9 ± 0.7 ABC	19.2 ± 3.0 AB	145.1 ± 12.2 BC
Stallion 3EC, 11.75 oz early + Mustang Max 0.8EC 4 oz at conventional timing	0.1 ± 0.0 C	0.9 ± 0.2 C	11.4 ± 1.6 ABC	23.6 ± 6.1 AB	153.2 ± 23.5 ABC
Baythroid XL, 2.8 oz**	0.2 ± 0.1 BC	1.9 ± 0.9 ABC	9.8 ± 1.1 ABC	24.1 ± 3.2 AB	154.5 ± 16.3 ABC
Endigo ZCX 2.71 ZC, 4 oz	0.5 ± 0.4 BC	0.9 ± 0.5 C	8.8 ± 0.8 ABC	29.5 ± 4.6 A	156.0 ± 17.5 ABC
Mustang Max 0.8EC, 4 oz**	0.2 ± 0.1 BC	1.2 ± 0.4 BC	10.2 ± 3.3 ABC	28.8 ± 5.8 A	164.7 ± 37.6 ABC
Stallion 3EC, 11.75 oz	0.8 ± 0.5 BC	0.5 ± 0.2 C	11.5 ± 1.4 ABC	27.6 ± 4.4 AB	165.0 ± 19.5 ABC
Warrior II, 1.92 oz**	0.1 ± 0.1 C	1.7 ± 1.0 ABC	12.0 ± 2.9 ABC	26.7 ± 3.7 AB	173.3 ± 32.4 ABC
Beseige 1.25 ZC, 9 oz	0.4 ± 0.2 BC	0.6 ± 0.1 C	11.7 ± 0.9 ABC	30.8 ± 5.5 A	175.8 ± 20.7 ABC
Mustang Max 0.8EC, 4 oz	0.1 ± 0.1 BC	1.3 ± 0.3 ABC	14.8 ± 1.7 ABC	27.0 ± 4.3 AB	189.1 ± 18.5 ABC
Mustang Max 0.8EC, 4 oz*	1.0 ± 0.4 AB	3.4 ± 0.8 AB	13.8 ± 2.7 ABC	22.1 ± 3.7 AB	191.5 ± 22.9 ABC
Baythroid XL, 2.8 oz*	1.0 ± 0.2 AB	3.6 ± 0.7 A	15.1 ± 1.9 ABC	19.5 ± 3.2 AB	194.8 ± 22.6 ABC
Warrior II, 1.92 oz*	0.5 ± 0.1 BC	2.0 ± 0.2 ABC	16.4 ± 2.9 AB	25.5 ± 3.4 AB	203.1 ± 23.7 ABC
Baythroid XL, 2.8 oz	0.3 ± 0.1 BC	1.4 ± 0.6 BC	12.8 ± 1.6 ABC	36.5 ± 7.5 A	206.9 ± 33.1 ABC
Mustang Max 0.8EC, 4 oz + Steward, 4 oz	0.2 ± 0.1 BC	2.1 ± 0.6 ABC	18.4 ± 3.3 AB	39.4 ± 9.0 A	257.2 ± 37.4 AB
Steward EC, 11.3 oz	1.3 ± 0.4 AB	3.8 ± 1.0 A	19.9 ± 3.6 A	32.2 ± 5.0 A	267.3 ± 30.0 A
F value	5.76	6.04	2.89	2.81	2.86
p>F	0.0000	0.0000	0.0004	0.0005	0.0004

[1]SE, standard error of the mean. Means in the same column followed by the same letter(s) are not statistically different, Tukey's HSD (∝=0.05).
[2]Calculated by the method of Ruppel (Journal of Economic Entomology 76: 375-7, 1983). The table is sorted by the means in this column.
*Early treatment date, **Early treatment date, repeated at conventional timing.

CONTROL OF BIOTYPE RWA2 RUSSIAN WHEAT APHID IN WINTER WHEAT WITH HAND-APPLIED INSECTICIDES, ARDEC, FORT COLLINS, CO, 2016

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CONTROL OF BIOTYPE RWA2 RUSSIAN WHEAT APHID IN WINTER WHEAT WITH HAND-APPLIED INSECTICIDES, ARDEC, FORT COLLINS, CO, 2016: Treatments were applied on 25 April 2016 with a 'rickshaw-type' CO_2 powered sprayer calibrated to apply 20 gal/acre at 3 mph and 32 psi through three 8002 (LF2) nozzles mounted on a 5.0 ft boom. Conditions at the time of treatment were cloudy and 55°F with 8 mph winds from the southeast. Plots were 6 rows (5.0 ft) by 25.0 ft and were arranged in randomized, complete block design with six replicates. Crop stage at application was jointing (Zadoks 32). The wheat had been infested with greenhouse-reared aphids on 26 February and 4 March 2016.

Treatments were evaluated for Russian wheat aphid control by collecting 20 symptomatic tillers along the middle four rows of each plot 8, 14 and 25 days after treatment (DAT). Tiller samples were placed in Berlese funnels for 24 hours to extract aphids into alcohol for counting. Symptomatic tiller samples taken the day of treatment averaged 4.2 Russian wheat aphids per tiller.

Aphid counts were transformed by the log + 1 method to correct for nonadditivity, and transformed counts were used for analysis of variance and mean separation by Tukey's Honestly Significant Difference (HSD) test (α=0.05). Original means are presented in Table 4. Total aphid days per tiller were calculated according the method of Ruppel (Journal of Economic Entomology 76: 375-7, 1983), transformed by the log + 1 method, and analyzed in the same manner, with original means presented in Table 4.

Aphid abundance was higher than in 2015, with approximately 29.9 aphids per tiller in the untreated control 25 DAT (Table 4) compared to 18.4 aphids per tiller 22 DAT in 2015. Crop condition was very good. All treatments had fewer aphid days than the untreated control. The Endigo ZCX 2.71 ZC, 4 fl oz, Warrior II 2.09 CS, 1.92 fl. oz., Stallion, 11.75 fl. oz., Lorsban Advanced, 16 fl. oz., and Mustang Max, 4.0 fl. oz. treatments reduced aphids per tiller at three weeks by 90% or more. This level of performance is considered to highly effective, based on results of past experiments.

Field History

Pest:	Russian wheat aphid, *Diuraphis noxia* (Kurdjumov)
Cultivar:	'Byrd'
Planting Date:	16 September 2015
Irrigation:	Pre-plant irrigation with linear move sprinkler
Crop History:	Fallow in 2015 crop year, no tillage
Herbicide:	None
Insecticide:	None prior to experiment
Fertilization:	None
Soil Type:	Sandy clay loam
Location:	ARDEC, 4616 North Frontage Road, Fort Collins, CO 80524, Field 1030, N40.65456, W104.99763

Table 4. Control of biotype 2 Russian wheat aphid in winter wheat with hand-applied insecticides, ARDEC, Fort Collins, CO. 2016.

PRODUCT, FL. OZ./ACRE[3]	RUSSIAN WHEAT APHIDS/TILLER ± SE[1] 8 DAT	14 DAT	25 DAT	APHID DAYS/TILLER[2] ± SEM	% REDUCTION IN APHID DAYS/TILLER
Endigo ZCX 2.71 ZC, 4 fl oz + COC 1% v/v	0.7 ± 0.4 B	0.2 ± 0.1 D	0.2 ± 0.0 D	21.3 ± 3.3 F	94
Warrior II 2.09 CS, 1.92 fl. oz.	0.9 ± 0.2 B	0.2 ± 0.1 CD	0.1 ± 0.0 D	23.2 ± 1.9 EF	94
Stallion, 11.75 fl. oz.	0.9 ± 0.1 B	0.3 ± 0.1 CD	0.3 ± 0.1 CD	24.6 ± 1.3 DEF	93
Lorsban Advanced, 16 fl. oz.	0.9 ± 0.3 B	0.4 ± 0.1 CD	0.4 ± 0.1 CD	25.5 ± 2.4 DEF	93
MustangMax, 4.0 fl. oz.	1.2 ± 0.4 B	0.4 ± 0.2 CD	0.8 ± 0.3 BCD	30.6 ± 3.7 CDEF	91
Cobalt Advanced, 11 fl. oz.	3.1 ± 2.4 B	0.6 ± 0.2 CD	1.0 ± 0.2 BCD	46.2 ± 17.4 BCDEF	87
Baythroid XL, 2.4 fl. oz.	1.6 ± 0.5 B	1.0 ± 0.2 BCD	2.6 ± 1.5 BCD	47.3 ± 11.1 BCDE	87
Sulfoxaflor 1.5 fl. oz. + COC 1% v/v	1.6 ± 0.3 B	0.5 ± 0.2 CD	4.0 ± 2.3 BC	51.8 ± 11.7 BCD	86
Dimethoate 267, 16 fl. oz.	1.4 ± 0.2 B	1.1 ± 0.2 BC	3.8 ± 0.7 B	54.2 ± 4.0 BC	85
Sulfoxaflor 0.75 fl. oz. + COC 1% v/v	2.1 ± 0.6 B	1.9 ± 0.4 B	3.4 ± 1.4 BC	63.4 ± 11.3 B	82
Untreated control	7.9 ± 1.3 A	14.5 ± 3.3 A	29.9 ± 6.8 A	357.5 ± 63.1 A	—
F value	7.21	40.04	20.46	31.00	—
p>F	0.0000	0.0000	0.0000	0.0000	—

[1]SE=standard error of the mean, DAT=days after treatment, Means in the same column followed by the same letter(s) are not statistically different, Tukey's HSD (∝=0.05).
[2]Calculated by the method of Ruppel (Journal of Economic Entomology 76: 375-7, 1983). The table is sorted by the means in this column.
[2]COC=crop oil concentrate.

CONTROL OF BIOTYPE RWA2 RUSSIAN WHEAT APHID IN SPRING MALT BARLEY WITH HAND-APPLIED INSECTICIDES, ARDEC, FORT COLLINS, CO, 2016

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CONTROL OF BIOTYPE RWA2 RUSSIAN WHEAT APHID IN SPRING MALT BARLEY WITH HAND-APPLIED INSECTICIDES, ARDEC, FORT COLLINS, CO, 2016: Treatments were applied on 12 May 2016 with a 'rickshaw-type' CO_2 powered sprayer calibrated to apply 20 gal/acre at 3 mph and 32 psi through three 8002 (LF2) nozzles mounted on a 5.0 ft boom. Conditions at the time of treatment were calm, hazy and 65°F. Plots were 6 rows (5.0 ft) by 25.0 ft and were arranged in six replicates of a randomized, complete block design. The barley was four inches tall at the time of application (Zadoks 25). The crop had been infested with greenhouse-reared aphids on 21 April 2016.

Treatments were evaluated for Russian wheat aphid control by collecting 20 symptomatic tillers along the middle four rows of each plot 8, 14 and 21 days after treatment (DAT). Tiller samples were placed in Berlese funnels for 24 hours to extract aphids into alcohol for counting. Symptomatic tiller samples taken 3 days before treatment averaged 2.8 Russian wheat aphids per tiller.

Aphid and counts were transformed by the square root + 0.5 method to correct for nonadditivity, and transformed counts were used for analysis of variance and mean separation by Tukey's Honestly Significant Difference (HSD) test (α=0.05). Original means are presented in Table 5. Total aphid days per tiller were calculated according the method of Ruppel (Journal of Economic Entomology 76: 375-7, 1983), transformed by the square root + 0.5 method, and analyzed in the same manner, with original means presented in Table 5.

Aphid abundance was similar to that observed in 2015, with approximately 8.7 aphids per tiller in the untreated control 21 DAT (Table 5) compared to 11.9 aphids per tiller 21 DAT in 2015. Crop condition was very good. All treatments had fewer aphid days than the untreated control. No treatment reduced aphid days per tiller at three weeks by 90% or more. This level of performance is considered to highly effective, based on results of past experiments.

Field History

Pest:	Russian wheat aphid, *Diuraphis noxia* (Kurdjumov)
Cultivar:	Moravian 37
Planting Date:	22 March 2016
Irrigation:	Overhead linear, no water applied.
Crop History:	Corn, conventional tillage
Herbicide:	Huskie, 13 fl.oz./acre on 24 May 2016
Insecticide:	None prior to experiment
Fertilization:	None
Soil Type:	Sandy clay loam
Location:	ARDEC, 4616 North Frontage Road, Fort Collins, CO 80524, Field 1035 Northwest N40.65458, W104.99729

Table 5. Control of biotype 2 Russian wheat aphid in spring malt barley with hand-applied insecticides, ARDEC, Fort Collins, CO. 2016.

PRODUCT, FL. OZ./ACRE[3]	RUSSIAN WHEAT APHIDS/TILLER ± SE[1] 8 DAT	14 DAT	21 DAT	APHID DAYS/TILLER[2] ± SE	% REDUCTION IN APHID DAYS/TILLER
Endigo ZCX 2.71 ZC, 4 fl. oz.	0.1 ± 0.0 A	0.5 ± 0.1 A	0.1 ± 0.0 D	62.3 ± 4.1 C	86
Cobalt Advanced, 11 fl. oz.	0.2 ± 0.1 A	0.5 ± 0.1 A	0.2 ± 0.1 D	66.4 ± 4.9 C	85
Warrior II 2.09 CS, 1.92 fl. oz.	0.1 ± 0.0 A	1.6 ± 1.1 A	0.2 ± 0.1 D	95.3 ± 30.6 BC	79
Baythroid XL, 2.4 fl. oz.	0.5 ± 0.2 A	0.8 ± 0.1 A	0.9 ± 0.3 CD	95.6 ± 11.8 BC	79
Besiege 1.25 ZC, 9 fl. oz.	1.0 ± 0.8 A	0.7 ± 0.2 A	0.3 ± 0.1 D	98.8 ± 26.7 BC	78
Sulfoxaflor 1.5 oz	0.3 ± 0.0 A	1.0 ± 0.3 A	1.8 ± 0.4 BC	108.8 ± 11.9 BC	76
Sulfoxaflor 0.75 oz	0.6 ± 0.2 A	1.8 ± 0.5 A	3.1 ± 0.2 B	163.4 ± 19.6 B	63
Untreated control	2.9 ± 0.6 B	6.5 ± 1.2 B	8.7 ± 1.7 A	445.7 ± 42.7 A	—
F value	7.14	11.10	40.36	26.36	
p>F	0.0000	0.0000	0.0000	0.0000	

[1]SE=standard error of the mean, DAT=days after treatment, Means in the same column followed by the same letter(s) are not statistically different, Tukey's HSD (∝=0.05).
[2]Calculated by the method of Ruppel (Journal of Economic Entomology 76: 375-7, 1983). The table is sorted by the means in this column.
[2]All treatments included crop oil concentrate 1% v/v.

CONTROL OF SPIDER MITES IN CORN WITH HAND-APPLIED INSECTICIDES AND MITICIDES, ARDEC, FORT COLLINS, CO, 2016

Frank Peairs, Jeff Rudolph, Darren Cockrell, Laura Newhard, Camden James and Bruce Gummonley, Department of Bioagricultural Sciences and Pest Management

CONTROL OF SPIDER MITES IN CORN WITH HAND-APPLIED INSECTICIDES AND MITICIDES, ARDEC, FORT COLLINS, CO, 2016: Early treatments were applied on 28 July 2016 using a two row boom sprayer mounted on a backpack calibrated to deliver 17.8 gal/acre at 32 psi with five XR8002VS nozzles. All other treatments were applied in the same manner on 12 August 2016. Conditions were cloudy, 70°F, and calm at the time of early treatments. Conditions were clear, 68° F and calm at the time of late treatments. Early treatments were applied at early pollination and late treatments were applied at early grain fill. All treatments, except the untreated control, were applied with Dyne-Amic 0.25% v/v. Because of the large number of treatments, the experiment was divided into two experiments of 20 treatments each. Three treatments were common to both experiemts for comparison purposes. Plots were 25 ft by two rows (30 inch centers) and were arranged in six replicates of a randomized complete block design. Plots were separated from neighboring plots by a single buffer row. Plots were infested on 7 July 2016 by laying mite infested corn leaves, collected earlier that day in Mesa County, CO, across the corn plants on which mites were to be counted. On 8 July 2016, the experimental area was treated with permethrin 3.2E, 8 fl oz/acre, to control beneficial insects and promote spider mite abundance.
Treatments were evaluated by collecting three leaves (ear leaf, 2nd leaf above the ear, 2nd leaf below the ear) from two plants per plot -1, 14, 21, 28, and 35 days after the early treatments (DAT). Corn leaves were placed in Berlese funnels for 48 hours to extract mites into alcohol for counting. Grain yields in both trials were estimated for the Brigade 2EC, 6.4 fl oz + Dimethoate 4E, 16 fl oz, late, Onager, 12 fl oz, early, and untreated control treatments by harvesting the ears from 0.001 acre per plot, drying and shelling the ears, weighing the dried grain, and converting yields to bu/acre at 15.5% moisture. Yield results from the two trials were combined and subjected to analysis of variance and mean separation by Tukey's Honestly Significant Difference (HSD) method ($\propto$=0.05). Mite counts were transformed by the square root + 0.5 method to address nonadditivity issues. Total mite days were calculated by the method of Ruppel (Journal of Economic Entomology 76: 375-377). Transformed counts and total mite days were subjected to analysis of variance and mean separation by Tukey's HSD method ($\propto$=0.05), with original means presented in Tables 6 and 7. Reductions in mite days were calculated by Abbott's (1925) formula: (percent reduction = ((untreated-treated)/untreated) X 100) using the average accumulated mite days of the untreated control.

Mite abundance was greater than that observed in 2015, with total mite days in the untreated control in the two trials averaging 1026 (Parts 1 and 2) and 544 in 2016 and 2015, respectively. In Part 1, Brigade 2EC, 6.4 fl oz + Dimethoate 4E, 16 fl oz, Onager 1E, 18 fl oz, early, Brigade 2EC, 6.4 fl oz, Onager 1E, 12 fl oz, early, Zeal 2.88 SC, 6 fl oz, early, Zeal 2.88 SC, 4 fl oz, early, Onager 1E, 12 fl oz + Dimethoate 4E, 16 fl oz, KFD-289-01 72 WG, 2 oz, early, Oberon 4SC, 5 fl oz + Dimethoate 4E, 16 fl oz, and Oberon 4SC, 5 fl oz, early had fewer mite days than the untreated control. In Part 2, Onager 1E, 16 fl oz, early, Onager 1E, 12 fl oz, early, Oberon 4SC, 6 fl oz, early, and Onager 1E, 14 fl oz, early, had fewer mite days than the untreated control. Yields for the three harvested treatments did not differ (df=2,22, F=3.00 and p>F=0.0704) and were 175.3, 171.5 and 158.5 bu/acre, respectively. No phytotoxicity was observed.

Field History:

Pest:	Banks grass mite, *Oligonychus pratensis* (Banks)
Cultivar:	Golden Harvest N29-T-3110
Planting Date:	5 May 2016
Plant Population:	34,000
Irrigation:	Linear move sprinkler
Crop History:	Experimental weed nursery in 2015
Herbicide:	31 May 2016, Roundup PowerMax, 1qt + AccuQuest WM, 6.4 fl.oz + Active Plus, 3.2 fl.oz + Sterling Blue, 6 f.loz + Aim EC, 0.5 fl.oz + KickStand Manganese 4% Extra, 1 qt 29 June 2016, Roundup PowerMax, 32 floz + Aim EC, 5.6 fl.oz + AccuQuest WM, 6.4 fl.oz + Active Plus, 3.2 fl.oz
Fertilization:	200 lb N, 80 lb P, 14 lb S, 5 lb Zn/acre on 13 April 2016
Soil Type:	Clay loam
Location:	ARDEC, 4616 North Frontage Road, Fort Collins, CO 80524, Field 1040 (N 104.9963, W40.6542)

Table 6. Control of spider mites in field corn with hand-applied miticides - Part 1, ARDEC, Fort Collins, CO, 2016.

	MITES PER LEAF ± SE[1]								
PRODUCT, FL OZ/ACRE*	**-1 DAT**	**14 DAT**		**21 DAT**		**28 DAT**		**35 DAT**	
Brigade 2EC, 6.4 fl oz + Dimethoate 4E, 16 fl oz	1.3 ± 0.5	7.3 ± 3.2	ABC	2.4 ± 1.7	D	3.8 ± 0.9	F	4.2 ± 1.5	D
Onager 1E, 18 fl oz**	1.9 ± 1.4	1.5 ± 1.0	C	3.2 ± 1.0	D	5.3 ± 1.0	F	10.9 ± 0.7	BCD
Brigade 2EC, 6.4 fl oz	0.8 ± 0.4	6.9 ± 2.3	ABC	6.7 ± 3.5	CD	5.3 ± 2.1	F	8.1 ± 2.2	CD
Onager 1E, 12 fl oz**	1.1 ± 0.5	4.8 ± 1.9	ABC	8.4 ± 2.8	BCD	7.2 ± 1.4	F	10.8 ± 3.4	BCD
Zeal 2.88 SC, 6 fl oz**	1.9 ± 1.5	11.0 ± 3.6	ABC	5.7 ± 2.1	CD	7.2 ± 1.2	F	11.7 ± 3.1	BCD
Zeal 2.88 SC, 4 fl oz**	3.4 ± 0.9	6.4 ± 2.2	ABC	4.9 ± 1.5	CD	12.4 ± 5.2	CDEF	11.8 ± 6.6	BCD
Onager 1E, 12 fl oz + Dimethoate 4E, 16 fl oz	2.1 ± 1.1	8.8 ± 3.0	ABC	9.6 ± 5.7	BCD	13.0 ± 7.5	CDEF	8.8 ± 3.7	CD
KFD-289-01 72 WG, 2 oz**	2.4 ± 1.2	3.4 ± 0.9	BC	10.4 ± 2.8	ABCD	14.2 ± 4.3	BCDEF	14.9 ± 3.2	ABCD
Oberon 4SC, 5 fl oz + Dimethoate 4E, 16 fl oz	1.8 ± 1.0	17.7 ± 3.1	A	5.1 ± 1.2	CD	10.6 ± 4.6	DEF	7.3 ± 1.0	CD
Oberon 4SC, 5 fl oz**	0.8 ± 0.2	6.1 ± 2.5	ABC	6.7 ± 2.9	CD	9.5 ± 5.1	EF	25.9 ± 5.4	ABCD
Zeal 2.88 SC, 3 fl oz**	2.0 ± 0.9	7.5 ± 2.0	ABC	6.9 ± 2.6	CD	10.4 ± 2.4	CDEF	34.1 ± 16.6	ABCD
KFD-216-02 50 WG, 24 oz**	0.6 ± 0.2	6.2 ± 1.6	ABC	8.0 ± 3.5	BCD	21.1 ± 4.8	BCDEF	21.1 ± 4.2	ABCD
KFD-272-01 2 SC, 7 fl oz**	2.2 ± 0.9	4.6 ± 1.2	ABC	8.5 ± 2.4	BCD	19.1 ± 7.5	BCDEF	25.9 ± 5.4	ABCD
KFD-268-01 80 WG, 10 oz**	0.4 ± 0.2	3.1 ± 1.0	BC	42.1 ± 9.5	A	30.8 ± 10.6	ABCDEF	52.7 ± 7.6	AB
KFD-268-01 80 WG, 15 oz**	4.2 ± 1.8	16.3 ± 4.1	AB	23.3 ± 6.9	ABCD	49.2 ± 13.4	ABC	23.7 ± 4.9	ABCD
KFD-217-01 480 SC, 24 fl oz**	0.8 ± 0.3	11.5 ± 4.0	ABC	9.9 ± 4.1	BCD	46.7 ± 15.2	ABCDE	54.1 ± 25.2	ABC
KFD-216-02 50 WG, 16 oz**	0.7 ± 0.2	17.4 ± 6.5	AB	45.7 ± 18.9	AB	32.1 ± 8.2	ABCDEF	38.0 ± 7.0	ABCD
KFD-217-01 480 SC, 16 fl oz**	0.9 ± 0.3	3.2 ± 1.0	BC	32.1 ± 10.6	ABC	46.4 ± 9.7	ABCD	60.5 ± 24.3	AB
Untreated control	2.1 ± 1.3	6.3 ± 1.7	ABC	31.1 ± 8.6	ABC	50.2 ± 10.1	AB	71.1 ± 26.2	A
KFD-286-01 6E, 42 fl oz**	0.6 ± 0.4	5.5 ± 1.2	ABC	23.3 ± 9.1	ABCD	73.7 ± 19.7	A	61.7 ± 18.2	AB
F value	1.23	3.21		4.96		7.04		4.56	
p>F	0.2503	0.0001		0.0000		0.0000		0.0000	

*Dyne-Amic nonionic surfactant 0.25% v/v used with all treatments, **early treatment date

[1]SE, standard error of the mean, DAT, days after the late treatment. Means in the same column followed by the same letter(s) are not statistically different, Tukey's HSD (∝=0.05).

Table 6 (continued). Control of spider mites in field corn with hand-applied miticides - Part 1, ARDEC, Fort Collins, CO, 2016.

PRODUCT, FL OZ/ACRE*	TOTAL MITE DAYS ± SE[2]		% REDUCTION IN TOTAL MITE DAYS
Brigade 2EC, 6.4 fl oz + Dimethoate 4E, 16 fl oz	172.3 ± 42.7	F	87
Onager 1E, 18 fl oz**	183.2 ± 24.4	F	86
Brigade 2EC, 6.4 fl oz	237.2 ± 69.4	F	82
Onager 1E, 12 fl oz**	269.3 ± 16.0	EF	80
Zeal 2.88 SC, 6 fl oz**	325.7 ± 64.8	DEF	75
Zeal 2.88 SC, 4 fl oz**	338.5 ± 69.9	CDEF	74
Onager 1E, 12 fl oz + Dimethoate 4E, 16 fl oz	372.6 ± 174.2	DEF	72
KFD-289-01 72 WG, 2 oz**	379.2 ± 72.7	CDEF	71
Oberon 4SC, 5 fl oz + Dimethoate 4E, 16 fl oz	395.5 ± 29.2	CDEF	70
Oberon 4SC, 5 fl oz**	398.0 ± 76.8	CDEF	70
Zeal 2.88 SC, 3 fl oz**	488.8 ± 157.4	BCDEF	63
KFD-216-02 50 WG, 24 oz**	494.5 ± 104.5	BCDEF	63
KFD-272-01 2 SC, 7 fl oz**	504.2 ± 105.0	ABCDEF	62
KFD-268-01 80 WG, 10 oz**	1022.4 ± 186.7	ABCDE	23
KFD-268-01 80 WG, 15 oz**	1045.3 ± 167.4	ABCD	21
KFD-217-01 480 SC, 24 fl oz**	1064.6 ± 330.7	ABCDE	20
KFD-216-02 50 WG, 16 oz**	1110.5 ± 205.0	ABCD	16
KFD-217-01 480 SC, 16 fl oz**	1175.6 ± 332.7	ABC	11
Untreated control	1322.8 ± 290.5	AB	0
KFD-286-01 6E, 42 fl oz**	1430.5 ± 323.9	A	—
F value	5.05		—
p>F	0.0270		—

*Dyne-Amic nonionic surfactant 0.25% v/v used with all treatments, **early treatment date

[1]SE, standard error of the mean. Means in the same column followed by the same letter(s) are not statistically different, Tukey's HSD (∝=0.05).

[2]Total mite days, calculated by the Ruppel method.

Table 7. Control of spider mites in field corn with hand-applied miticides - Part 2, ARDEC, Fort Collins, CO, 2016.

	MITES PER LEAF ± SE[1]				
PRODUCT, FL OZ/ACRE*	**-1 DAT**	**14 DAT**	**21 DAT**	**28 DAT**	**35 DAT**
Onager 1E, 16 fl oz**	1.1 ± 0.6 AB	1.8 ± 0.5 B	8.9 ± 4.0 B	4.3 ± 0.8 CDE	9.1 ± 2.3 CDE
Onager 1E, 12 fl oz**	0.4 ± 0.2 AB	6.1 ± 3.4 AB	4.5 ± 1.0 B	3.6 ± 1.0 DE	6.0 ± 0.8 DE
Oberon 4SC, 6 fl oz**	0.2 ± 0.1 B	2.1 ± 0.6 AB	4.7 ± 1.9 B	7.7 ± 0.4 ABCDE	11.2 ± 2.5 CDE
Onager 1E, 14 fl oz**	2.2 ± 1.1 AB	4.1 ± 0.7 AB	5.4 ± 1.7 B	4.8 ± 0.8 CDE	14.3 ± 6.2 BCDE
Brigade 2EC, 6.4 fl oz + Dimethoate 4E, 16 fl oz	4.3 ± 1.4 AB	8.7 ± 1.7 AB	2.7 ± 1.2 B	2.2 ± 0.5 E	8.8 ± 1.9 CDE
Brigade 2EC, 6.4 fl oz	1.6 ± 0.9 AB	5.0 ± 3.2 AB	8.6 ± 3.2 B	4.9 ± 1.8 CDE	13.4 ± 5.0 BCDE
GWN-10194 1E, 12 fl oz**	0.9 ± 0.3 AB	5.2 ± 1.4 AB	9.2 ± 1.8 B	8.2 ± 2.3 ABCDE	7.7 ± 1.0 CDE
GWN-10194 1E, 16 fl oz**	2.1 ± 0.5 AB	10.1 ± 4.5 AB	5.7 ± 1.5 B	4.8 ± 1.2 CDE	6.1 ± 2.0 DE
Onager 1E, 24 fl oz**	2.6 ± 2.2 AB	2.6 ± 0.5 AB	2.4 ± 0.5 B	4.6 ± 1.8 DE	4.1 ± 0.7 E
GWN-10194 1E, 14 fl oz**	2.1 ± 0.8 AB	8.6 ± 3.3 AB	9.7 ± 2.1 B	6.3 ± 1.8 BCDE	11.8 ± 2.5 BCDE
GWN-14010, 7 fl oz	0.8 ± 0.3 AB	4.1 ± 1.1 AB	10.1 ± 2.6 B	12.1 ± 2.3 ABCDE	15.8 ± 6.1 BCDE
Dimethoate 4E, 16 fl oz	1.1 ± 0.3 AB	7.7 ± 1.4 AB	4.9 ± 2.5 B	14.5 ± 5.2 ABCDE	12.7 ± 4.4 BCDE
GWN-14010, 7 fl oz**	0.3 ± 0.2 AB	3.8 ± 1.3 AB	20.7 ± 7.3 AB	13.6 ± 2.4 ABCDE	13.4 ± 2.1 BCDE
GWN-14010, 5 fl oz	0.9 ± 0.5 AB	5.8 ± 1.9 AB	16.9 ± 5.5 AB	14.7 ± 6.1 ABCDE	26.4 ± 11.1 ABCDE
GWN-14010, 6 fl oz	2.1 ± 1.0 AB	8.2 ± 1.9 AB	13.2 ± 3.5 B	15.7 ± 5.4 ABCDE	35.9 ± 8.2 ABC
Portal XLO, 32 fl oz	1.2 ± 0.5 AB	7.7 ± 1.4 AB	25.4 ± 7.0 AB	27.4 ± 6.5 AB	22.9 ± 5.5 ABCDE
GWN-14010, 6 fl oz**	0.3 ± 0.2 B	6.2 ± 1.7 AB	16.6 ± 3.9 AB	25.5 ± 10.3 ABC	24.8 ± 4.2 ABCDE
Portal XLO, 32 fl oz**	2.4 ± 0.7 AB	7.8 ± 2.1 AB	19.8 ± 4.2 AB	28.3 ± 5.8 A	44.0 ± 9.3 AB
Untreated control	2.9 ± 1.7 AB	9.8 ± 2.7 AB	24.3 ± 6.7 AB	23.0 ± 8.9 ABCD	52.9 ± 12.5 A
GWN-14010, 5 fl oz**	6.1 ± 2.7 A	13.2 ± 2.9 A	63.5 ± 33.0 A	16.1 ± 4.5 ABCDE	31.4 ± 8.5 ABCD
F value	1.96	1.86	4.27	4.59	5.35
p>F	0.0181	0.0270	0.0000	0.0000	0.0000

*Dyne-Amic nonionic surfactant 0.25% v/v used with all treatments, **early treatment date

[1]SE, standard error of the mean, DAT, days after the late treatment. Means in the same column followed by the same letter(s) are not statistically different, Tukey's HSD ($\propto$=0.05).

Table 7 (continued). Control of spider mites in field corn with hand-applied miticides - Part 2, ARDEC, Fort Collins, CO, 2016.

PRODUCT, FL OZ/ACRE*	TOTAL MITE DAYS ± SE[2]		% REDUCTION IN TOTAL MITE DAYS
Onager 1E, 16 fl oz**	114.1 ± 14.8	E	84
Onager 1E, 12 fl oz**	144.7 ± 37.5	E	80
Oberon 4SC, 6 fl oz**	149.7 ± 20.3	E	79
Onager 1E, 14 fl oz**	178.9 ± 30.6	DE	75
Brigade 2EC, 6.4 fl oz + Dimethoate 4E, 16 fl oz	187.1 ± 22.1	CDE	74
Brigade 2EC, 6.4 fl oz	204.9 ± 44.9	BCDE	72
GWN-10194 1E, 12 fl oz**	208.8 ± 21.8	BCDE	71
GWN-10194 1E, 16 fl oz**	215.1 ± 44.2	BCDE	70
Onager 1E, 24 fl oz**	222.1 ± 109.2	E	70
GWN-10194 1E, 14 fl oz**	258.6 ± 48.2	BCDE	65
GWN-14010, 7 fl oz	258.8 ± 34.7	BCDE	65
Dimethoate 4E, 16 fl oz	268.5 ± 61.2	BCDE	63
GWN-14010, 7 fl oz**	329.2 ± 79.6	BCDE	55
GWN-14010, 5 fl oz	380.9 ± 117.2	ABCDE	48
GWN-14010, 6 fl oz	429.1 ± 94.0	ABCDE	41
Portal XLO, 32 fl oz	441.0 ± 78.8	ABCD	40
GWN-14010, 6 fl oz**	447.8 ± 111.2	ABCDE	39
Portal XLO, 32 fl oz**	592.9 ± 77.0	AB	19
Untreated control	731.5 ± 168.0	ABC	0
GWN-14010, 5 fl oz**	848.4 ± 229.9	A	—
F value	5.83		—
p>F	0.0000		—

*Dyne-Amic nonionic surfactant 0.25% v/v used with all treatments, **early treatment date

[1]SE, standard error of the mean. Means in the same column followed by the same letter(s) are not statistically different, Tukey's HSD (∝=0.05).

[2]Total mite days, calculated by the Ruppel method.

2016 PEST SURVEY RESULTS

Table 8. 2016 pheromone trap catches at ARDEC, Fort Collins, CO.

	ARDEC – 1030*	
Species	**Total Caught[2]**	**Trapping Period**
Army cutworm	13 (162)	8/16 - 11/7
Banded sunflower moth	47 (155)	5/16 – 10/24
Beet armyworm	57 (44)	5/16 - 10/31
European corn borer (IA)[1]	23 (20)	5/16 - 10/3
Fall armyworm	160 (387)	4/26 - 10/24
Pale western cutworm	27 (37)	8/16 - 10/24
Sunflower moth	15(5)	5/16 – 10/24
Western bean cutworm	19 (0)	5/16 - 10/24
Wheat head armyworm	31 (46)	4/26 - 10/10
Wheat stem sawfly	3 (0)	5/11 - 7/13

* (N40.654201, W104.997667)
[1] IA, Iowa strain
[2]–, not trapped. Number in () is 2015 total catch for comparison

WHEAT STEM SAWFLY SURVEY 2016

Claire Tovrea, Chrissy Ward, Darren Cockrell, Bruce Gammonley, Laura Newhard and Frank Peairs, Department of Bioagricultural Sciences and Pest Management.

WHEAT STEM SAWFLY SURVEY 2016: The wheat stem sawfly, *Cephus cinctus* Norton, is a major pest of wheat and other cereals, but also utilizes a wide range of grass hosts. Its distribution includes the northern Great Plains region, reaching from North Dakota and Montana to southeastern Wyoming and Colorado and the Nebraska panhandle.

Wheat stem sawfly adults emerge in late May to early June, generally around the time winter wheat is in late stem elongation or early boot. Females insert eggs inside the stems of wheat, usually near a node. Larvae hatch within 5-7 days and feed downward through the stem for approximately one month. When the plants begin to mature, the larvae move to the base of the plant, cut a small v-shaped notch around the stem and fill the end of the stem with frass. The larvae overwinter within a thin cocoon that they construct to prevent them from dessication. In early spring, larvae pupate and emerge as adults when conditions are favorable. Wheat stem sawfly has one generation per year.

In 2010, the wheat stem sawfly was found in winter wheat in northeastern Colorado. In 2011, damaging populations were found in winter wheat planted near New Raymer, CO, where 40% lodging from the sawfly was observed. A one-day survey, conducted in 2011 in northeastern Colorado at anthesis revealed that 57% of the fields surveyed were infested with wheat stem sawfly. A more formal survey was initiated in 2012.

Approximately 100 samples are collected annually, with the samples per county based on the number of acres each county had in wheat production in 2010. Samples are taken as near as possible to the sites used in 2012, for comparison purposes. Each site is a minimum of 10 miles from its closest neighbor to allow appropriate mapping and to improve the distribution of samples with counties. Each site consisted of a wheat field that shared a field edge with a fallow wheat field. The two fields are directly adjacent and not separated by barriers or roads.

GPS coordinates were recorded at each location using a Garmin model GPSmap76S. A hand drawn map was then made for ease of returning to sites. Data on previous crop, presence of adjacent alternative host grasses, tillage type, stubble/residue percent cover, irrigation, county and wheat growth stage were recorded.

Wheat stem sawfly adult and larval presence and abundance was determined. Adults were collected by 100 180°sweeps with a standard insect sweep net within the wheat crop, along the field edge closest to the adjacent fallow, during the sawfly flight. Contents of the net were then emptied into ziplock plastic bags and transported in coolers. The samples were then stored in the freezer for later sawfly counts and future genetic analyses. After anthesis, each site was revisited to collect tillers for determining percentage of larval infestation. Whole plants were dug up along the wheat/fallow border and were placed into ziplock bags and transported to the lab in coolers. The plants were kept in a refrigerator and later dissected to determine percentage larval infestation.

Maps of wheat stem sawfly infested and non-infested sites were constructed using Carta DB. Different colored circles indicate the level of infestation and white circles indicates no sawfly present (See Figure 1). Results from previous surveys are summarized in Table 9.

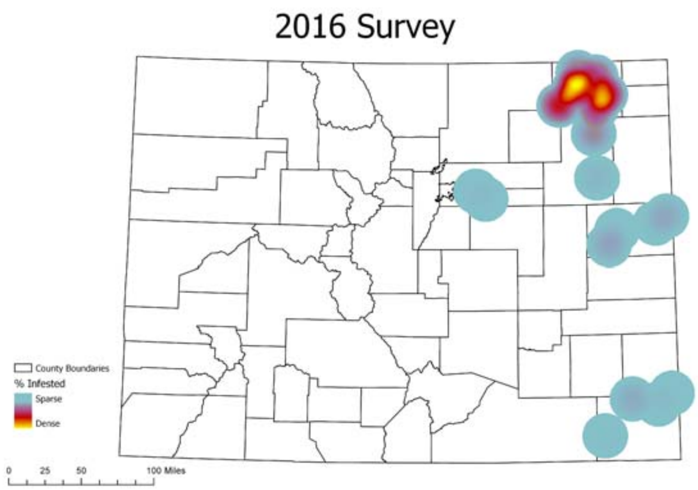
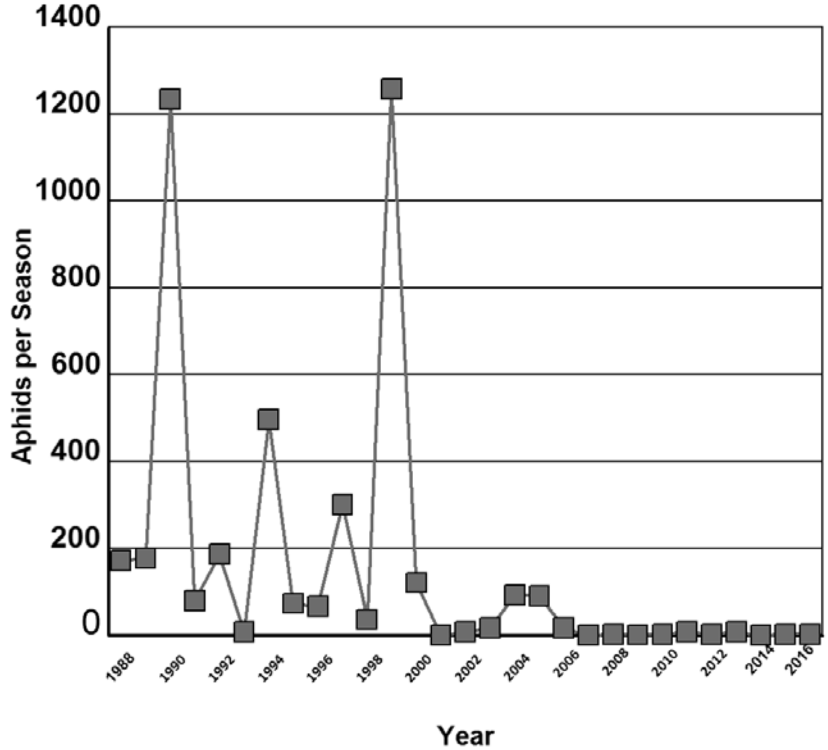


Figure 1

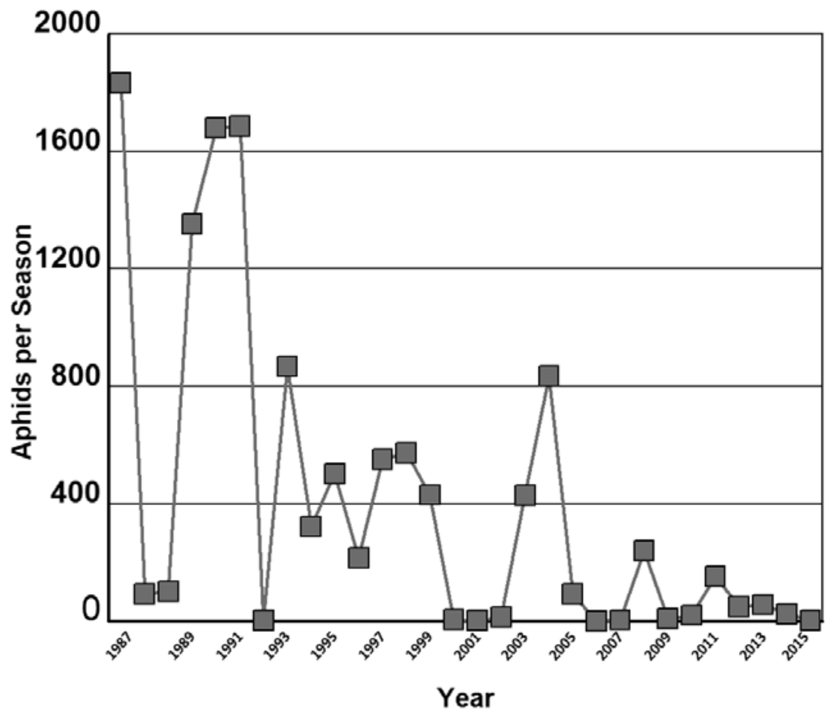
Table 9. Colorado wheat stem sawfly survey: 2012 - 2016.

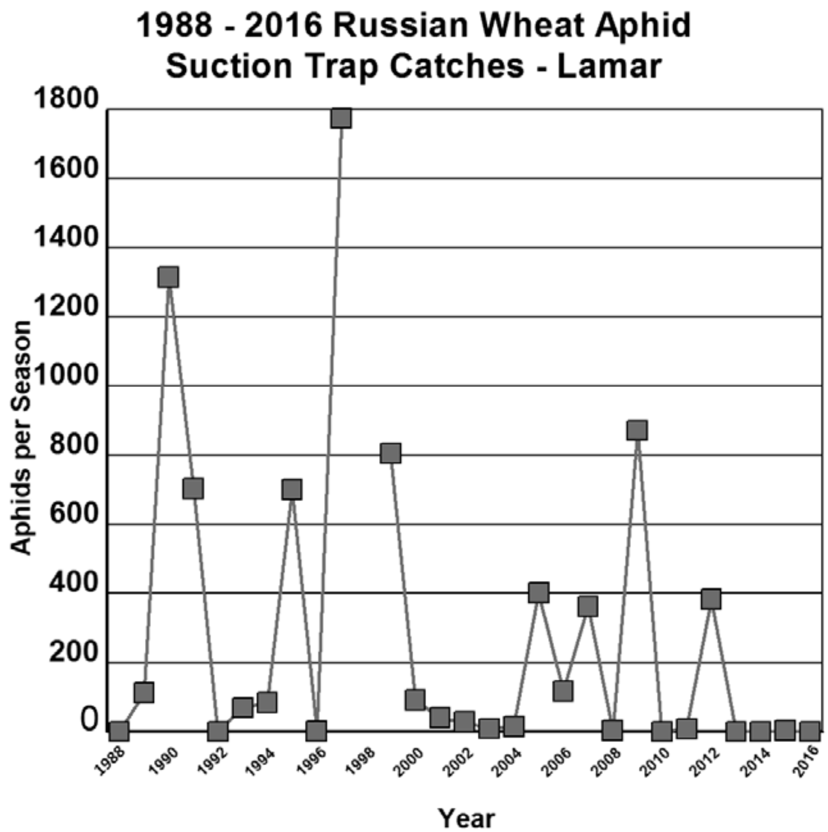
	% Fields in Each Infestation Category				
Infestation Category	**2012**	**2013**	**2014**	**2015**	**2016**
Uninfested	74	66	50	34	46
Low (<10% infested stems)	18	17	30	47	37
Medium (10 - 50% infested stems)	6	13	15	17	12
High (>50% infested stems)	2	4	5	2	5
Total Infested Fields	**26**	**34**	**50**	**66**	**54**

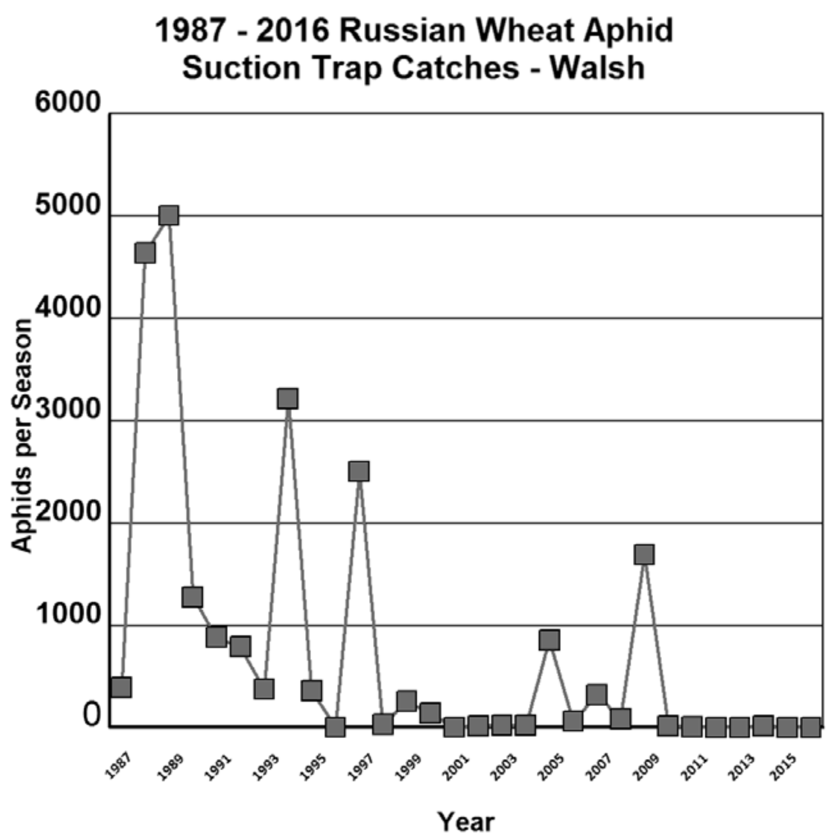
1988 - 2016 Russian Wheat Aphid Suction Trap Catches - Akron



1987 - 2016 Russian Wheat Aphid Suction Trap Catches - Fort Collins




1988 - 2016 Russian Wheat Aphid
Suction Trap Catches - Lamar
Aphids per Season
0
200
400
600
800
1000
1200
1400
1600
1800
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year


1987 - 2016 Russian Wheat Aphid
Suction Trap Catches - Walsh
Aphids per Season
0
1000
2000
3000
4000
5000
6000
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
Year

INSECTICIDE PERFORMANCE SUMMARIES

Insecticide performance in a single experiment can be quite misleading. To aid in the interpretation of the tests included in this report, long term performance summaries are presented below for insecticides that are registered for use in Colorado and that have been tested at least three times. These summaries are complete through 2016.

Table 10. Performance of planting-time insecticides against western corn rootworm, 1987-2016, in northern Colorado.

INSECTICIDE	0 -3 ROOT RATING[1]
AGRISURE RW	0.14 (7)
AZTEC 2.1G	0.06 (35)
COUNTER 15G	0.06 (38)
CRUISER, 1.25 mg (AI)/seed	0.06 (10)
FORCE 1.5G (8 OZ) or 3G (4 OZ)	0.06 (32)
FORCE 3G (5 OZ)	0.07 (12)
FORCE CS, 0.46 oz	0.09 (3)
FORTRESS 5G	0.08 (14)
HERCULEX RW or xTRA	0.13 (6)
LORSBAN 15G	0.12 (31)
PONCHO 600, 1.25 mg (AI)/seed	0.04 (8)
SMARTSTAX	0.04 (3)
THIMET 20G	0.50 (15)
UNTREATED CONTROL	1.10 (40)

[1]Rated on the node damage scale of 0-3, where 0 is least damaged, and 3 is 3 root nodes completely damaged. Ratings taken prior to 2006 were based on the Iowa 1-6 scale and approximated to the 0-3 scale. Number in parenthesis is number of times the product was tested in average. Planting time treatments averaged over application methods.

Table 11. Performance of cultivation insecticide treatments against western corn rootworm, 1987-2005, in northern Colorado.

INSECTICIDE	IOWA 1-6 ROOT RATING[1]
COUNTER 15G	2.8 (21)
FORCE 3G	3.3 (8)
LORSBAN 15G	3.1 (17)
THIMET 20G	2.9 (19)
UNTREATED CONTROL	4.2 (24)

[1]Rated on a scale of 1-6, where 1 is least damaged, and 6 is most heavily damaged. Number in () is number of times tested for average. Planting time treatments averaged over application methods.

Table 12. Insecticide performance against first generation European corn borer, 1982-2002, in northeast Colorado.

MATERIAL	LB/ACRE	METHOD[1]	% CONTROL[2]
DIPEL ES	1 QT + OIL	I	91 (4)
LORSBAN 15G	1.00 (AI)	A	77 (5)
LORSBAN 15G	1.00 (AI)	C	80 (6)
LORSBAN 4E	1.0 (AI)	I	87 (9)
POUNCE 3.2E	0.15 (AI)	I	88 (11)
POUNCE 1.5G	0.15 (AI)	C	87 (4)
POUNCE 1.5G	0.15 (AI)	A	73 (7)
THIMET 20G	1.00 (AI)	C	77 (4)
THIMET 20G	1.00 (AI)	A	73 (3)
WARRIOR 1E	0.03 (AI)	I	85 (4)

[1]A = Aerial, C = Cultivator, I = Center Pivot Injection. CSU does not recommend the use of aerially-applied liquids for control of first generation European corn borer.
[2]Numbers in () indicate that percent control is the average of that many trials.

Table 13. Insecticide performance against western bean cutworm, 1982-2002, in northeast Colorado.

MATERIAL	LB (AI)/ACRE	METHOD[1]	% CONTROL[2]
CAPTURE 2E	0.08	A	98 (5)
CAPTURE 2E	0.08	I	98 (5)
LORSBAN 4E	0.75	A	88 (4)
LORSBAN 4E	0.75	I	94 (4)
POUNCE 3.2E	0.05	A	97 (7)
POUNCE 3.2E	0.05	I	99 (5)
WARRIOR 1E (T)	0.02	I	96 (2)

[1]A = Aerial, I = Center Pivot Injection
[2]Numbers in () indicated that percent control is average of that many trials.

Table 14. Insecticide performance against second generation European corn borer, 1982-2002, in northeast Colorado.

MATERIAL	LB (AI)/ACRE	METHOD[1]	% CONTROL[2]
DIPEL ES	1 QT PRODUCT	I	56 (16)
CAPTURE 2E	0.08	A	85 (8)
CAPTURE 2E	0.08	I	86 (14)
LORSBAN 4E	1.00 + OIL	I	72 (14)
POUNCE 3.2E	0.15	I	74 (11)
WARRIOR 1E	0.03	A	81 (4)
WARRIOR 1E	0.03	I	78 (4)

[1]A = Aerial, I = Center Pivot Injection
[2]Numbers in () indicate how many trials are averaged.

Table 15. Performance of hand-applied insecticides against alfalfa weevil larvae, 1984-2016, in northern Colorado.

PRODUCT	LB (AI)/ACRE	% CONTROL AT 2 WK[1]
BAYTHROID XL	0.022	92 (21)
BAYTHROID XL	0.022 (early)[3]	88 (13)
COBALT OR COBALT ADVANCED	19 fl oz	88 (8)
LORSBAN 4E	0.75	93 (23)
LORSBAN 4E	1.00	88 (13)
LORSBAN 4E	0.50	83 (10)
MUSTANG MAX	0.025	89 (11)
MUSTANG MAX	0.025 (early)[3]	86 (13)
PERMETHRIN [2]	0.10	67 (7)
PERMETHRIN [2]	0.20	80 (4)
STALLION	11.75 FL OZ	92 (5)
STEWARD EC	0.065	80 (7)
STEWARD EC	0.110	84 (11)
WARRIOR 1E or T or II	0.02	92 (18)
WARRIOR II	0.03 (early)[3]	86 (7)
WARRIOR 1E or T or II	0.03	89 (14)

[1]Number in () indicates number of years included in average.
[2]Includes both Ambush 2E and Pounce 3.2E.
[3]Early treatment timed for control of army cutworm

Table 16. Control of Russian wheat aphid with hand-applied insecticides in winter wheat, 1986-2016[1].

PRODUCT	LB (AI)/ACRE	TESTS WITH CONTROL > 90%	TOTAL TESTS	% TESTS
LORSBAN 4E	0.50	31	53	58
COBALT ADVANCED	11 FL OZ	3	8	38
BAYTHROID XL	0.019	0	10	0
DIMETHOATE[2]	0.375	9	45	20
ENDIGO 2.71 ZCX	4 FL OZ	4	7	58
MUSTANG MAX	0.025	3	14	21
LORSBAN 4E	0.25	10	27	37
LORSBAN 4E	0.375	5	6	83
WARRIOR[2]	0.03	5	22	23

[1]Includes data from several states; [2]several formulations.

Table 17. Control of spider mites in artificially-infested corn, ARDEC, 1993-2016.

PRODUCT	LB (AI)/ACRE	% REDUCTION IN TOTAL MITE DAYS[1]
CAPTURE 2E	0.08	47 (21)
CAPTURE 2E + DIMETHOATE 4E	0.08 + 0.50	66 (23)
COMITE II	1.64	17 (17)
COMITE II	2.53	37 (9)
COMITE II + DIMETHOATE 4E	1.64 + 0.50	55 (13)
DIMETHOATE 4E	0.50	45 (21)
OBERON 4SC	0.135	50 (8)
OBERON 4SC	0.156	60 (7)
OBERON 4SC	0.188	52 (6)
ONAGER 1E	0.078	69 (9)
ONAGER 1E	0.094	70 (6)
PORTAL XLO (early)	0.10	44 (4)
PORTAL XLO (late)	0.10	46 (3)
ZEAL	0.09	46 (5)

[1]Number in () indicates number of tests represented in average. 2009 data not included.

Table 18. Control of sunflower stem weevil, USDA Central Great Plains Research Station, 1998-2002.

PRODUCT	LB (AI)/ACRE	TIMING	% CONTROL[1]
BAYTHROID 2E	0.02	CULTIVATION	57 (3)
BAYTHROID 2E	0.03	CULTIVATION	52 (3)
WARRIOR 1E	0.02	CULTIVATION	63 (3)
WARRIOR 1E	0.03	CULTIVATION	61 (3)

[1]Number in () indicates number of tests represented in average.

ACKNOWLEDGMENTS

2016 COOPERATORS

PROJECT	LOCATION	COOPERATORS
Alfalfa insecticides	ARDEC, Fort Collins	Karl Whitman, Mark Collins
Barley insecticides	ARDEC, Fort Collins	Karl Whitman, Mark Collins
Corn spider mite control	ARDEC, Fort Collins	Karl Whitman, Mark Collins, Bob Hammon
Russian wheat aphid control	ARDEC, Fort Collins	Karl Whitman, Mark Collins
Wheat stem sawfly control	New Raymer	Jim and Cole Mertens
Pheromone traps	ARDEC, Fort Collins	Karl Whitman, Mark Collins
Suction trap	ARDEC, Fort Collins	Karl Whitman, Mark Collins
Suction trap	Akron (Central Great Plains Research Station)	Dave Poss, Merle Vigil
Suction trap	Lamar	Jensen Stulp
Suction trap	Walsh (Plainsman Research Center)	Deb Harn, Kevin Larson

PRODUCT INDEX

Agrisure RW Manufacturer: Syngenta
Genetic insertion events: MIR604
Active ingredient(s) (common name): mCry3A 22

Ambush 2E
Manufacturer: AMVAC
EPA Registration Number: 5481-549
Active ingredient(s) (common name): cypermethrin. 24

Aztec 2.1G
Manufacturer: AMVAC
EPA Registration Number: 5481-9030
Active ingredient(s) (common name): 2% tebupirimphos, 0.1% cyfluthrin 22

Baythroid XL
Manufacturer: Bayer CropScience
EPA Registration Number: 264-840
Active ingredient(s) (common name): cyfluthrin 5-7, 9, 11, 24, 25

Besiege 1.25 ZC
Manufacturer: Syngenta
EPA Registration Number: 100-1402
Active ingredient(s) (common name): lambda-cyhalothrin + chlorantraniliprole. 11

Brigade 2EC
Manufacturer: FMC
EPA Registration Number: 279-3313
Active ingredient(s) (common name): bifenthrin. 12, 14-17

Capture 2E
Manufacturer: FMC
EPA Registration Number: 279-3069
Active ingredient(s) (common name): bifenthrin. 23-25

Cobalt Advanced
Manufacturer: Dow Agrosciences
EPA Registration Number: 62719-615
Active ingredient(s) (common name): chlorpyrifos + lambda cyhalothrin 5-7, 9, 11, 24, 25

Comite II
Manufacturer: Chemtura
EPA Registration Number: 400-154
Active ingredient(s) (common name): propargite 25

Counter 15G
Manufacturer: AMVAC
EPA Registration Number: 5481-545
Active ingredient(s) (common name): terbufos 22

Cruiser
Manufacturer: Syngenta
EPA Registration Number: 100-941
Active ingredient(s) (common name): thiamethoxam 22

Dimethoate
Manufacturer: generic
EPA Registration Number: various
Active ingredient(s) (common name): dimethoate 9, 12, 14-17, 25

Dipel ES
Manufacturer: Valent
EPA Registration Number: 73049-17
Active ingredient(s) (common name): Bacillus thuringiensis 23, 24

Endigo ZCX 2.71 ZC
Manufacturer: Syngenta
EPA Registration Number: experimental
Active ingredient(s) (common name): lambda cyhalothrin + thiamethoxam 5-9, 11

Force 3G
Manufacturer: Syngenta
EPA Registration Number: 100-1075
Active ingredient(s) (common name): tefluthrin 22

Force CS
Manufacturer: Syngenta
EPA Registration Number: 100-1253
Active ingredient(s) (common name): tefluthrin 22

GWN-10194
Manufacturer: Gowan
EPA Registration Number: NA
Active ingredient(s) (common name): experimental 16, 17

GWN-14010
Manufacturer: Gowan
EPA Registration Number: NA
Active ingredient(s) (common name): experimental 16, 17

Herculex RW
Manufacturer: Dow Agrosciences
Genetic insertion event DAS 59122-7
Active ingredient(s) (common name): Cry34/35Ab1 22

KFD-216-02 50 WG
Manufacturer: UPL
EPA Registration Number: NA
Active ingredient(s) (common name): experimental 14, 15

KFD-217-01 480 SC
Manufacturer: UPL
EPA Registration Number: NA
Active ingredient(s) (common name): experimental 14, 15

KFD-268-01 80 WG
Manufacturer: UPL
EPA Registration Number: NA
Active ingredient(s) (common name): experimental 14, 15

KFD-272-01 2 SC
Manufacturer: UPL
EPA Registration Number: NA
Active ingredient(s) (common name): experimental 14, 15

KFD-286-01 6E
Manufacturer: UPL
EPA Registration Number: NA
Active ingredient(s) (common name): experimental 14, 15

Lorsban 15G
Manufacturer: Dow Agrosciences
EPA Registration Number: 62719-34
Active ingredient(s) (common name): chlorpyrifos 22, 23

Lorsban 4E
Manufacturer: Dow Agrosciences
EPA Registration Number: 62719-220
Active ingredient(s) (common name): chlorpyrifos 23-25

Lorsban Advanced
Manufacturer: Dow Agrosciences
EPA Registration Number: 62719-591
Active ingredient(s) (common name): chlorpyrifos 5-9

Mustang Max
Manufacturer: FMC
EPA Registration Number: 279-3249
Active ingredient(s) (common name): zeta cypermethrin. 3, 5-8, 24, 25

Oberon 4SC
Manufacturer: Bayer CropScience
EPA Registration Number: 264-850
Active ingredient(s) (common name): spiromesifen 12, 14-17, 25

Onager 1E
Manufacturer: Gowan
EPA Registration Number: 10163-277
Active ingredient(s) (common name): hexythiazox 12, 14-17, 25

Poncho 600
Manufacturer: Bayer CropScience
EPA Registration Number: 264-789
Active ingredient(s) (common name): clothianidin 22

Portal XLO
Manufacturer: Nichino America
EPA Registration Number: 71711-40
Active ingredient(s) (common name): fenpyroximate 16, 17, 25

Pounce 1.5G
Manufacturer: FMC
EPA Registration Number: 279-3059
Active ingredient(s) (common name): permethrin 23

Pounce 3.2E
Manufacturer: FMC
EPA Registration Number: 279-3014
Active ingredient(s) (common name): permethrin 23, 24

Smartstax
Manufacturer: Dow Agrosciences
Genetic insertion events: MON 89034 x TC1507 x MON 88017 x DAS-59122-
Active ingredient(s) (common name): Cry 1A.l05 + Cry2Ab2 + Cry34/35Ab1 + Cry 1F 22

Stallion
Manufacturer: FMC
EPA Registration Number: 279-9545
Active ingredient(s) (common name): zeta cypermethrin + chlorpyrifos 5-9, 24

Steward
Manufacturer: DuPont
EPA Registration Number: 352-598
Active ingredient(s) (common name): indoxacarb 3, 5-7, 24

Sulfoxaflor (Transform WG)
Manufacturer: Dow Agrosciences
EPA Registration Number: 62719-625
Active ingredient(s) (common name): sulfoxaflor 9, 11

Thimet 20G
Manufacturer: Amvac
EPA Registration Number: 5481-530
Active ingredient(s) (common name): phorate 22, 23

Warrior II with Zeon Technology (Warrior II 2.09 CS)
Manufacturer: Syngenta
EPA Registration Number: 100-1295 (other formulations are indexed)
Active ingredient(s) (common name): lambda-cyhalothrin 8, 9, 11

Zeal Miticide
Manufacturer: Valent
EPA Registration Number: 59639-138
Active ingredient(s) (common name): etoxazole 12, 14, 15, 25