

Influence of Admire® and Platinum® on the Population Growth of the Lettuce Aphid Under Field Conditions

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Abstract

Studies to examine lettuce aphid population growth on Admire and Platinum treated plants were conducted on head lettuce at the Yuma Agricultural Center. By artificially infesting plants on several lettuce plantings during the spring, the influence of insecticide residual and temperature were measured. Results of five field trials suggest that both Admire and Platinum can have a significant influence on lettuce aphid population growth. Depending on timing of infestation and insecticide residual, significant suppression of population growth can result from the application of these compounds. Infestations initiated at 28 d following Admire application initially resulted in minimal population growth, but later allowed aphids to reproduce at high numbers. In both cases, Admire provided about 90% control of the lettuce aphid population. However, aphid infestations occurring at later periods of plant residual almost always resulted in higher population development. In addition, these studies also support conclusions drawn from last season that suggested lettuce aphid population growth is greatest when ambient temperatures average between 65-70 °F.

Introduction

A new aphid species, the currant-lettuce aphid, *Nasonovia ribisnigri* (Mosley), has been creating problems for lettuce growers throughout the western United States. Commonly referred to as the lettuce aphid, the pest was found in Salinas in 1998 causing economic losses to summer head and leaf lettuce crops. Infestations of this species were also reported on lettuce in the Imperial Valley, central Arizona, and Baja California, Mexico in early 1999. They have consistently appeared throughout lettuce growing areas of California and Arizona during the past two years, particularly in organically produced lettuce. Aphid populations in the Yuma area have occurred at very low levels in most commercial fields where Admire® applied on an areawide basis appears to have prevented large-scale outbreaks.

There is much uncertainty surrounding this new species, and its ability to thrive within our desert growing conditions. An important question is: Will soil applications of systemic insecticides (Admire, Platinum) provide seasonal control of the lettuce aphid? Theoretically, Admire should provide good control of the lettuce aphid, as it does other aphid species. It has been the standard product used for aphid control in desert lettuce for the past 7 years. A single at-planting application usually provides season-long control of green peach and potato aphids. This is achieved by preventing aphid colonization early-mid season when these aphids feed on leaves lower on the plant where Admire has systemically moved to. However, we are not sure of the duration of residual control in lettuce

heads treated with Admire or Platinum on spring crops. Therefore we conducted field trials where we artificially-infested treated lettuce plants with lettuce aphids and compared their rate of population growth under various field conditions.

Methods and Materials

Studies to examine aphid population growth on treated and untreated plants were conducted on head lettuce at the Yuma Agricultural Center, Yuma, Arizona. Three separate 0.25 acre plots of head lettuce ‘Diamond’ were planted on Dec 15th, Jan 8th and Feb 4th. On each planting date lettuce was direct seeded into double row beds on 42 inch centers. Each planting was subdivided into plots consisted of 4 beds, 80 feet long. Plots were arranged in a randomized complete block design with four replications with a total of 8 plots established in each planting. Within each planting, five plots were randomly selected and imidacloprid (Admire 2F) at 20 oz / acre was applied. The Admire was applied to plots during the bed-shaping operation by injecting the chemical 1.5" below the seed. Plots were furrow irrigated to a stand. The remaining five plots were left untreated at planting. Additionally, in each planting, thiamethoxam (Platinum 2SC) was applied post-planting at a rate of 9 oz/acre as a side dress application to ½ of each untreated plots (2 beds * 80 ft) on 20 Feb. Side dress applications were made by placing the product near the bed shoulder at approximately 3-4 " below the soil. Plots were irrigated 2 days following side dress on Feb 22. No other insecticide applications were made during the study.

Five separate studies were established by infesting individual plants with either reproductive mature or immature apterae lettuce aphids. Aphids used in this study were reared in the field. An infestation of lettuce aphid was discovered in another test in December 2000, and from this, a lettuce aphid nursery was established in a romaine plot located about 1 mile to the south of the experimental area. Specimens of this population were verified as *Nasonovia ribisnigri* (Mosley), by Dr. John Sorensen, CDFA, Sacramento, CA.

In the first trial, 3 reproductive mature apterous aphids were placed onto the terminal of 4-leaf head lettuce plants using a camel hair brush. A total of 5 plants in each Admire and untreated subplot replicate were infested (20 plants per treatment) and marked on Jan 29. Aphid population were left unmolested for 35 days, after which each marked (artificially infested) plant was individually removed from the field and brought into the laboratory for examination. All foliage on each plant was visually examined for alatae, and immature and reproductive apterous lettuce aphids. Numbers of aphids per plant were recorded for each plant and averaged for each treatment. In the remaining four trials, 5 immature apterous aphids were infested on the same number of plants and population numbers were sampled similarly to trial 1. In trials 2 (Dec 15th planting) and 3 (Jan 8th planting), lettuce aphids were also artificially infested in Platinum-treated plots. Trials 4 and 5 were conducted in the Feb 4th lettuce planting and evaluated similarly. Details for infestation periods and temperature (AZMET station, Yuma Valley; <http://ag.arizona.edu/azmet/>) are shown in Table 3. In addition, in each trial, five plants unmarked plants from each plot were randomly sampled as above to determine the natural lettuce aphid infestation occurring in the experimental plots. This was done to measure the incidence of naturally-occurring aphids migrating onto artificially infested plants. Mean differences in aphid numbers among treatments following infestation periods were determined using a one-way ANOVA and a protected LSD, or with paired t-tests ($p < 0.05$). The intrinsic rate of increase in aphid population growth for each treatment was calculated from: $r_t = \ln(n_{t+1}) - \ln(n_0) / t$; where n_t and n_0 represent the number of aphids at the end of the infestation period and the number artificially infested on each plant at the beginning of the time interval t , respectively.

Results and Discussion

Lettuce aphid population growth for each trial is shown in Tables 1 and 2. In Trial 1, differences in the mean number of aphids per plant were not significant between the Admire and untreated treatments in the artificially-infested plants. The Admire residual in the plants (45 days after injection) did not appear to provide adequate protection under these conditions. Total aphid numbers increased above 100 plants per plant after 35 days. Although temperatures were sub-optimal, this population growth was expected because 3 reproductive apterous were placed on each plant allowing for immediate reproduction. What influence this has on the effects of Admire are unknown. However, we would not expect to see this under commercial situations, as further demonstrated by the

low aphid numbers found in the naturally infested plants. Population growth on treated and untreated plants was much lower when plants were infested with 5 immature apterous lettuce aphids. In Trial 2, both Admire and Platinum plots had significantly fewer aphids than the untreated check (Table 2). Surprisingly, plants in the natural infestation were actually more heavily infested with lettuce aphids than the artificially infested trial, which may be a reflection of how this aphid tends to become highly aggregated upon migration into fields. In Trial 3, lettuce aphid numbers were significantly lower in the insecticide treatments, where Admire and Platinum reduced aphid numbers by 91 and 71 % respectively. Similar reductions in aphid numbers among were seen in the treatments in the naturally infested plots, but overall numbers were much lower than seen in Trial 2.

Trials 4 and 5 showed some interesting results (Table 2). At 28 days following planting, the artificial infestation resulted in almost no population increase of apterous aphids, compared with substantial growth in the untreated. The intrinsic growth rates also demonstrate this. In fact, this was the highest growth rate seen in the entire study for untreated plants and lowest on the Admire treated plants (Table 3). Admire activity at 28-d residual seems to be efficacious on the small plants seen in this trial. Furthermore, natural population infestation was very low during this period. Similarly in Trial 5, following a 32 d infestation period, resulted in significantly fewer aphids in the Admire treated plots. Although a higher number of aphids occurred on Admire treated plants, their intrinsic rate of increase was less than half of the untreated plots. What mortality factors are responsible for this is unknown based on these data, but could be due to immature mortality or repellency, occurring from the anti-feedant properties of Admire. In addition, sub-lethal effects of Admire on reproduction could possibly have occurred. Naturally occurring aphid populations were higher than seen in the artificial population and certainly confound the results. From a practical perspective, Admire provided greater than 90 and 80% reduction in infestation in the artificially- and naturally infested plant, respectively. Unfortunately, the numbers infesting the harvested heads in the Admire treatments would probably not be commercially acceptable.

In conclusion, these field trials suggest that both Admire and Platinum have a significant influence on lettuce aphid population growth. Depending on residual, significant control can result from the application of these compounds. For instance, infestation initiated at 28 d following planting initially resulted in minimal population growth, but later allowed aphids to reproduce at high numbers. In both cases, Admire provided about 90% control of the lettuce aphid population. Under natural conditions, control wasn't quite as good, and probably reflects the aggregating behavior of this aphid species. However, aphid infestations occurring at later periods of plant residual almost always resulted in higher population development. Similarly, Platinum performed best when applied as a 2nd side dress to larger plants when the plant root system was more advanced. In addition, these studies also support conclusions drawn from last season that suggested that population growth was greatest when temperatures averaged between 65-70 °F. Although, population growth for aphids was high in the first trial when temperature averaged 56 °F, the presence of reproductive immatures was probably a greater influence. The highest aphid growth rates coincided with average ambient temperatures of 66°F (Table 3). Previous studies in the laboratory (Bill Chaney, Univ. Calif., personal communication), and in the fields suggest that this is the optimal developmental range. Finally, we should not be quick to draw too many conclusions from these studies. Although insecticides and temperatures clearly influenced population growth rates, natural occurring lettuce aphid infestations may have also skewed our results, particularly in Trials 2 and 5 when lettuce aphids numbers in the field were very high. More importantly though, other factors such as variety, planting date, plant growth stage, infestation pressure and natural enemies will also certainly affect the rate at which lettuce aphids develop in lettuce.

Table 1. Effects of Admire and Platinum on population increase of lettuce aphids in artificially infested head lettuce, YAC, 2001.

Trial (<i>plant age at time of infestation</i>)	Plant stage	Infestation period	Source of infestation ^a	Treatment	Mean <i>Nosonovia ribis-nigri</i> / plant						
					Apterae			Total			
					Alatae	Immature	Reproductive				
Trial 1 (45 d) Dec 15 wet date	4 leaf	35 d	Artificial	Admire	0.8	119.0	16.4	135.4			
				Untreated	5.9 <i>ns</i>	273.4 <i>ns</i>	44.9 <i>ns</i>	317.3 <i>ns</i>			
				Natural	Admire	0.2	0.9	0.1	1.1		
			Untreated	0.3 <i>ns</i>	3.9 <i>ns</i>	1.6 <i>ns</i>	5.5 <i>ns</i>				
			Trial 2 (65 d) Dec 15 wet date	12 leaf	28 d	Artificial	Admire	0.1 a	7.9 b	1.3 a	9.2 b
							Platinum	0.2 a	5.4 b	0.6 a	6.0 b
Untreated	0.1 a	31.3 a					2.3 a	33.6 b			
Natural	Admire	0.3 a				11.3 b	3.3 b	14.6 b			
	Platinum	0.4 a				3.3 b	0.9 b	4.1 b			
	Untreated	0.4 a				75.0 b	15.6 a	90.6 a			
Trial 3 (40 d) Jan 8 wet date	4 leaf	28 d	Artificial	Admire	0.4 a	9.3 b	1.2 a	10.5 b			
				Platinum	0.6 a	28.9 b	2.4 a	31.3 b			
				Untreated	0.4 a	103.7 a	7.3 a	111.0 a			
			Natural	Admire	0.3 a	0.9 b	0.3 a	1.2 b			
				Platinum	0.8 a	1.4 b	0.3 a	1.7 b			
				Untreated	0.3 a	7.2 a	0.7 a	7.8 a			

Significant difference between means as detected by a paired t-test; *, P<0.05; ** p<0.01; *ns*, treatment means not significantly different; Multiple treatments analyzed using a ANOVA with a or by protected LSD (P<0.05)

^{a/} Artificial; reproductive or immature apterous lettuce aphids placed on each plant; lettuce aphids were reared in a field insectary. Naturally occurring lettuce aphids were not found on plants prior to artificial infestation. Natural; lettuce aphids were not placed on these plants; aphids naturally infested found on plants by immigration from outside of the field.

Table 2. Effects of Admire on population increase of lettuce aphids in artificially infested head lettuce, YAC, 2001.

Trial (<i>plant age at time of infestation</i>)	Plant stage	Infestation period	Source of infestation ^a	Treatment	Mean <i>Nasonovia ribis-nigri</i> / plant			
					Apterae			Total
					Alatae	Immature	Reproductive	
Trial 4 (28 d) Feb 4 wet date	4 leaf	17 d	Artificial	Admire	0.3	5.1	0.3	5.4
				Untreated	1.8 *	60.6 *	4.1 *	65.8 *
			Natural	Admire	0.3	2.2	0	2.2
				Untreated	0.8 <i>ns</i>	2.2 <i>ns</i>	0 <i>ns</i>	2.2 <i>ns</i>
Trial 5 (28 d) Feb 4 wet date	4 leaf	32 d	Artificial	Admire	0.5	34.5	5.9	40.4
				Untreated	2.2 <i>ns</i>	280.5 **	47.0 **	327.9 **
			Natural	Admire	2.3	111.5	23.3	134.7
				Untreated	8.4 *	410.1 **	66.3 *	476.4 *

Significant difference between means as detected by a paired t-test; *, P<0.05; ** p<0.01; *ns*, treatment means not significantly different; Multiple treatments analyzed using a ANOVA with a or by protected LSD (P<0.05)

^{a/} Artificial; reproductive or immature apterous lettuce aphids placed on each plant; lettuce aphids were reared in a field insectary. Naturally occurring lettuce aphids were not found on plants prior to artificial infestation. Natural; lettuce aphids were not placed on these plants; aphids naturally infested found on plants by immigration from outside of the field.

Table 3. Rate of population increase (r_t) of lettuce aphids artificially infested on head lettuce plants and average ambient temperatures during the infestation periods, YAC, 2001.

Trial (Planting Date)	Infestation period (days)	Average ambient temperatures (°F)		Treatment	Aphid rate of increase (r_t)	
		Max-Min	Mean		Immature	Reproductive
1 (Dec 15)	Jan 29- Mar 4 (35 d)	69-43	56	Admire	0.097	0.042
				Untreated	0.121	0.069
2 (Dec 15)	Feb 20- Mar 20 (28 d)	76-50	63	Admire	0.014	0.009
				Platinum	0.002	0.001
				Untreated	0.060	0.029
3 (Jan 8)	Feb 20- Mar 20 (28 d)	76-50	63	Admire	0.019	0.006
				Platinum	0.056	0.031
				Untreated	0.102	0.076
4 (Feb 4)	Mar 4-Mar 21 (17 d)	82-49	66	Admire	0.001	0.001
				Untreated	0.137	0.083
5 (Feb 4)	Mar 4-April 5 (32 d)	83-51	67	Admire	0.055	0.061
				Untreated	0.120	0.129