

Insect Crop Losses and Insecticide Usage for Head Lettuce in Arizona: 2004 - 2006

John Palumbo, Al Fournier, Peter Ellsworth, Kurt Nolte, and Pat Clay

Abstract

Impact assessment is central to the evolution and evaluation of our IPM programs. Quantifiable metrics on insecticide use patterns, costs, targets, and frequency, crop losses due to all stressors of yield and quality, and other real world economic data (e.g., crop value) are our most objective tools for assessing change in our systems. We recently initiated a project to measure the impact of insect losses and insecticide uses in head lettuce grown in Yuma, AZ and the Bard–Winterhaven area of Imperial County, CA. The data generated in this report is useful for responding to pesticide information requests generated by EPA, and can provide a basis for regulatory processes such as Section 18 or 24c requests, as well as for evaluating the impact of our extension programs on risk reduction to growers. This information also confirms the value of PCAs to the lettuce industry by showing the importance of cost-effective management of insect pests in desert lettuce production.

Introduction

The development of accurate “real world” data on crop insect losses and insecticide usage is important to the assessment of our IPM programs in Arizona. Quantifiable measurements of insecticide use patterns, costs, target pests, and yield/quality losses due to key insect pests are our most objective tools for assessing change in our systems. These data allow us to build relevant databases for measuring user behaviors and adoption of new IPM technologies. This is information important for several reasons. First, specific data on pesticide use patterns and insect losses can be useful for providing information to EPA and other regulatory agencies in submitting Section 18 and 24c requests, as well as support the tolerance of older active ingredients that are critical to the lettuce industry. In addition, it can directly demonstrate the value of new pest control technologies and IPM tactics. From an academic perspective, these databases help to re-direct the efforts of the College of Agriculture by providing key stakeholder input to our applied research and extension programs. This “real world” input from the industry documents the relevancy of key pest problems and has become mandatory for competing for federal grant funding. Finally, for pest control advisors (PCAs), it can translate their efforts into economic terms for their clientele and confirms their value to the lettuce industry by showing the importance of key insect pests and their cost-effective management in desert lettuce production. This report documents the development of “real world” data on actual insect loss data for head lettuce and estimates of the level of insecticidal control needed to prevent key insect pests from reducing yield and quality.

Data Collection

The data was developed through the administration of a three-part survey that was conducted in an interactive process with stakeholder input. Growers, PCAs, Extension personnel and industry professionals attended Head Lettuce Insect Losses and Impact Assessment Workshops in Yuma in April of 2005 and 2006 and completed surveys in a guided process. The workshops were conducted in an interactive manner where participants were given a presentation that established the incentives for participation, explained the crop insect loss system, and further walked the participants through the estimation process. The three part survey instrument collected the following information:

Part I: Information was collected on the actual head lettuce acreage represented by the respondent, estimates of actual yields and potential yields for this acreage (Table 1), and overall percent reductions in yields due to several biological, environmental and management factors (Table 2). In addition, costs associated with aerial and ground applications (Table 3) and insect management fees for scouting (Table 4) were estimated.

Part II. Information was collected on crop insect losses through the description of the percentage of acres where key insect pests were present and insecticide sprays were required to prevent yield reductions. Included with those estimates are the frequency and costs of insecticide applications directed towards those insects. Overall, these costs represent a loss to the grower associated with preventing insects from damaging plants and reducing yields. Finally, actual percent yield losses (heads not harvested due to insect damage or injury) for individual insect species or complexes were estimated (Table 5 and 6).

Part III: Data on insecticide use patterns was collected. These data identify the frequency of use of various chemistries (identified by both product name and IRAC mode-of-action classification) and the percentage of treated acres for each product (Table 9).

To provide data consistent with head lettuce production in the desert southwest, separate information was collected for Fall lettuce acres (crops grown from September through November) and Spring lettuce acres (December-March) because of differences in weather and insect pressures. Ideally, this data will allow us to track changes in insect crops losses and insecticide use patterns over time in great detail for both fall and spring head lettuce.

Results and Discussion

Part I: The 2005-2006 Head Lettuce Insect Losses workshop in Yuma was attended by 55 growers, PCAs, Extension personnel and other stakeholders (up from 42 the previous year). A total of 19 surveys were completed, representing about 80% of the combined lettuce acreage in the Yuma and Imperial Valley areas (up about 15% from the previous year) (Table 1). The large majority of acres reported were for head lettuce grown in Yuma county (~85%), with the remainder representing the adjacent Bard/Winterhaven area of Imperial County, CA. Because of their proximity and similarities to each other, data were combined for these two growing areas in each year. Estimates of yields (both actual and potential) varied slightly between year and crop season, and suggests that annual estimates for yield losses are about 20-22%. These values are also fairly consistent with the PCA and grower estimates of specific factors responsible for yield losses.

Estimates for specific factors responsible for seasonal yield reduction varied as well (Table 2). Overall, weather and disease constituted the factors that PCAs and growers felt were most responsible for yield reduction, particularly in spring lettuce. This is commonly when lettuce is grown in cooler temperatures and higher amounts of rainfall. This was definitely the case in the spring of 2005 when we had unusually high amounts of rainfall (almost 3X more than the average). Disease pressure is also heavier during the spring (i.e. downey mildew), particularly under wet growing conditions. Losses for all insects ranged from 1.9-3.6 % and varied between years and seasons. This is consistent with the unpredictable nature of insect outbreaks that are often influenced by weather. Not surprisingly, yield reductions due to birds was >2 %. PCAs have reported that crop losses due to bird damage have been getting worse each year in lettuce. We did not specifically collect information on birds in the 2004-2005 survey, but many respondents listed bird damage as a significant factor for yield reduction in the "other factors" category. Percent reduction in yield by other factors included: birds, vertebrates, poor crop management practices, poor lettuce markets/marketing, salt and poor weeding/thinning practices. Collectively, these factors were responsible for >3% of the annual crop losses in head lettuce.

Estimates for aerial and ground insecticide applications on head lettuce were fairly consistent between years (Table 3). In general, nearly 90% of all acres are treated by both air and ground on an average of about 5 times per acre. Average costs for insecticides applied by ground were almost 40% higher than applied by air. Not surprisingly, respondents estimated that 100% of their acres were scouted, monitored and sampled for insect activity (Table 4). The number of field visits per week was higher in the fall, and may be indicative of the intense pest pressure that can

occur in Sep-Oct as well as the rapid rate of plant growth. Estimates for the cost of scouting per acre increased almost 15% from 2004-2006 to an average of \$24.50 / acre. It was not documented why these costs increased in one year, but as discussed openly after the 2006 workshop, may be a reflection of the increased cost of lettuce production, and in particular chemicals and fuel. Irregardless, these insect management costs suggest that Arizona lettuce growers find significant value in the expertise and service provided by their PCAs.

Part II: Insect Crop Losses

Fall Head Lettuce: Insects important at stand establishment such as seedling pests (ground beetles, earwigs, crickets, and salt marsh caterpillars) were treated on greater than 50 % of the lettuce acreage (Table 5). Slightly more than 1 spray treatment at an average cost of less than \$15.00 per acre was used to manage these pests. However, this complex of pests accounted for an estimated 2.6% yield loss at stand establishment in the fall of 2004. In 2005, PCAs reported a higher number of treated acres, and less crop loss. Similarly, flea beetles were treated on a consistent basis in fall lettuce on > 30% of the acreage. Yield losses to flea beetles averaged about 1% across both years. Leafminers were present on less than 8% of the fall acreage, requiring treatments at a considerably higher cost, and resulting in marginal yield losses.

The lepidopterous larval complex consisting of beet armyworm, cabbage looper and budworm/ bollworm accounted for the greatest number of applications in fall head lettuce in both years. This complex was present on 100% of the acreage and required an average of \$112.68 /acre to control for beet armyworm, and \$87.23/acre for cabbage looper. This is based on the high numbers of sprays required and at average control costs ranging from \$24.20-\$30.90 in 2004-2005 to greater than \$31.00/acre in 2005-2006. This increase in control likely reflects the increased price for agrichemicals that PCAs and growers often comment on. Corn earworm was less prevalent and control costs were lower. Yield losses to this complex also varied by species and between years, but in general losses due to beet armyworm were highest.

Whiteflies (sweetpotato whitefly, *Bemisia tabaci* – B biotype) were reported to be present on nearly 100% of the fall crop, and required additional foliar sprays on 76.5% and 26.9 % of the fall acres in 2004-2005 and 2005-2006 respectively. Control costs with foliar sprays ranged from \$43.95 – \$59.08 / acre. Admire was applied to 65.9% and 80.1% of the fall acreage (Tables 7 and 8) at an average cost of \$60.97/acre. Despite higher, area-wide whitefly populations in 2005-2006 (Palumbo, unpublished), similar yield losses were reported in both years. The aphid complex consisting of green peach aphid, foxglove aphid and lettuce aphid accounted for very little yield loss and the number of treated acres was less than 15% in either year. This is to be expected as aphids are usually a pest of spring lettuce in the desert.

Western flower thrips has emerge as one of the key pests of desert head lettuce. Known mainly as a key pest of spring lettuce, thrips have become more numerous and troublesome in fall production. Estimates showed that greater than a third of fall lettuce acreage was treated for thrips at an average control cost ranging from \$36.96 - \$41.86 per acre. Crop losses for thrips on fall lettuce were estimated at about 0.5%. Similarly trash bugs (false chinch bugs, *Lygus* spp., and other insect contaminants) accounted for a fairly high number of treated acres in fall lettuce, but at a much lower cost than thrips control.

Spring Head Lettuce: Insects important at stand establishment are generally thought to be less important on spring crops because of the cooler weather and the lack of other crops such as cotton and Sudan grass to provide a source of infestation. Data in Table 6 tends to support this, as nearly 50% fewer acres were treated for seedling pests in spring lettuce and yield losses were comparably lower. However, yield losses to seedling pests in 2004-2005 were higher compared to most other pests in spring lettuce. The presence of flea beetles and leafminers were similarly lower in the spring, requiring control on less than 15% of the acreage.

Lepidopterous larve also required less management on spring lettuce. Estimates showed that cabbage looper was the predominate species on spring crops, requiring higher control costs and causing slightly more yield loss than beet armyworm or corn earworm. This is consistent with our previous observations of lepidopterous larval activity on spring lettuce. Surprisingly, respondents reported that spray treatments were made on a minor number of acres for whiteflies on spring lettuce in both years. This was not expected as we generally consider whiteflies a pest of fall crops. However, yield losses attributed to whiteflies were negligible in both years.

As expected, the number of acres treated for aphids on spring lettuce was much higher than reported for fall crops. The percentage of treated acres ranged from 56-61 % for green peach aphid at an average cost of \$59.50 / acre across both years. This aphid species accounted for about 1.2 % yield loss in both years. Acreage treated for the foxglove aphid, which has recently become an established pest of desert lettuce, increased to 21% in 2005-2006 and control costs for a single application against this species were slightly higher than green peach aphid. Although lettuce aphid is not considered a wide-spread pest in desert lettuce, PCAs estimated that 2-6.8% of the acres were treated for this aphid species over the past two spring crops, requiring almost 2 sprays to control the pest. Overall, aphids accounted for over 2 sprays per season. It is important to note that Admire applications made to spring lettuce are specifically targeted for aphid control. However, less than 80% of the acres are treated, thus foliar applications are often required. In the case of the foxglove aphid, Admire often provides marginal control and can require additional foliar sprays.

Data in Table 6 indicates that thrips are by far the predominate pest of spring lettuce. Greater than 75% of the spring lettuce acreage was treated for thrips in both years at an average cost of \$70.00 / acre. Even with this considerable expense, PCAs estimated yield losses as high as 1.7% in 2005-2006. Trash bugs were similarly high in spring lettuce, particularly in 2005-2006 where nearly 50% of the acres were treated for false chinch bugs and *Lygus* spp. contaminating mature lettuce heads.

Part III: Insecticide Usage

The frequency of use and the percentage of treated acres for insecticides in head lettuce are shown in Table 9. The individual insecticide products are grouped by the IRAC mode-of-action classification (<http://www.irac-online.org>). This system groups chemistries with a similar mode-of-action with a common number so that users can effectively rotate different chemistries in resistance management programs. We list insecticides by a product name when possible; otherwise the chemical name is listed. Pyrethroids were listed by class only because of the numerous products registered in head lettuce. We also separated pyrethroid and diazinon by both foliar and chemigation uses.

The carbamate and organophosphate chemistries are listed within IRAC Group 1 because of their common mode-of-action. Among this group, Lannate (methomyl) was the most commonly used product in both acreage treated and number of applications per acre. In both years, Lannate usage was highest in spring lettuce. This is not surprising as many PCAs feel that Lannate/pyrethroid combinations are the industry standard for thrips control. Usage in fall lettuce would be targeted for both thrips and beet armyworm. No usage was reported for Larvin. Diazinon was also commonly used as a single chemigation treatment at stand establishment, particularly in fall head lettuce. Foliar diazinon use was marginal in both fall and spring crops. Orthene and Dimethoate use was minor on fall lettuce, but used at a much greater frequency and intensity on spring lettuce. Both of these products are effective tank-mix partners for aphids and thrips. Endosulfan (Group 2A) was used on about 20% of fall lettuce acres, presumably for whitefly and lepidopterous larvae control. Use of endosulfan increased to greater than 35% in spring crops, likely due to its efficacy as a tank-mix partner against aphids and thrips.

Foliar applications of pyrethroids (Group 3) were consistently the most heavily used insecticide in both spring and fall head lettuce. Use in fall lettuce ranged from 96.7-99.8 % treated acres in 2004-2005 to slightly less than that in 2005-2006. Pyrethroids were applied as foliar sprays 2.9-3.5 times per treated acre. Pyrethroids were applied as a single chemigation treatment at stand establishment on greater than 50% of the fall acreage, and on about 15% few acres in spring crops. Combined, diazinon and pyrethroids were applied to more than 90% of the fall lettuce acreage. The intensity and frequency of pyrethroid use in head lettuce is consistent with its broad spectrum activity against pests such as darkling beetle, flea beetle, thrips and lepidopterous larvae adults that are often not controlled with many of the new, selective insecticides.

Group 4A represents the neonicotinoid chemistry which includes Admire, Provado and Assail. Admire was used on about 65 % of the acreage of both fall and spring lettuce in 2004-2005. However, the percentage of treated acres increased by 15% in 2005-2006, perhaps in response to the heavy whitefly pressure observed in August and early September. In contrast, Provado use was minimal on fall lettuce in both years. This insecticide is primarily targeted against aphids on spring lettuce as a tank-mix partner where it was applied on almost 25% of the acreage in 2004-2005. PCAs reported a 70% decrease in Provado use on spring lettuce in 2005-2006, likely due to the registration of Assail in 2005 which was applied to 33.9% of the spring lettuce acres at an average of 1.3 times. Another aphicide that may have been affected by Assail use was Fulfill (Group 9B), where the percentage of treated spring lettuce acres declined by 30% in 2005-2006.

The second most heavily used compound in Arizona head lettuce was Success (Group 5). The percentage of treated acres increased slightly between years, but spray frequency declined slightly. Usage of Success in fall lettuce is primarily targeted against lepidopterous larvae where 2.6-2.8 applications / acre were made. Another product used for lepidopterous larvae control in fall lettuce was Intrepid (18A), which was treated on about 60% of the acres. Proclaim (6) use on lettuce increased more than two fold on fall lettuce between years, and similarly Avaunt (22) usage increased as well. These products were used at lower frequency and intensity on spring lettuce as lepidopterous larvae pressure is generally lighter in the spring. However, the percentage of acres treated with Success remained at 88.4% and 89.4 % on spring lettuce in 2004-2005 and 2005-2006 respectively, despite lighter worm pressure and relatively moderate usage of the worm-selective Intrepid. The heavy reliance of Success on spring lettuce is likely due to its use for thrips control where it is recommended to be used in rotation with Lannate. Similarly, Agrimek (5) is an effective insecticide compound for leafminer control, but PCAs reported no use of the product in either year. Again this may be due to the high use of Success, which has good activity against leafminers on lettuce.

Products that are approved for both organic and conventional lettuce production (Entrust, BT, and Azadirachtin/Neem) were used on less than 3% of the reported head lettuce acreage. Surprisingly, Oberon, a newly registered product with whitefly activity was used on 3.9% of the spring acreage, when whiteflies damage to lettuce is generally considered to be rare.

Acknowledgements

We would first and foremost like to thank all the PCAs and growers who took time out of their busy schedules to participate in the workshops that made these data available. We would also like to thank Joy Denning and Judy Gill (Yuma Ag Center), and Jean Carter (Yuma county Cooperative Extension) who assisted in the planning and preparation of the Lettuce Insect Losses Workshops in Yuma. Finally, funding for these workshops was made possible by a grant from the Western Integrated Pest Management Center.

Table 1. Number of respondents and reported acreage and yields for fall and spring lettuce in the 2004-2005 and 2005-2006 growing seasons.

Survey use stats	Fall Lettuce		Spring Lettuce	
	2004-05	2005-06	2004-05	2005-06
No. of PCA respondents	15		19	
Acreage reported for these estimates	19,760	24,300	14,210	21,970
Estimated yield /acre (cartons)	777	738	796	828
Potential yield / acre (cartons)	966	981	1016	1019

Table 2. Percent reductions in yields due to several biological, environmental and management factors for fall and spring lettuce in the 2004-2005 and 2005-2006 growing seasons.

Factor	Yield Reduction (%)			
	Fall Lettuce		Spring Lettuce	
	2004-05	2005-06	2004-05	2005-06
Weather	7.5	4.8	9.7	4.9
Chemical injury	0.7	0.5	0.6	0.8
Weeds	1.6	1.8	1.9	2
Disease	5.9	6.2	13.6	11.2
All insects	1.9	3.6	2.5	1.9
Birds	-	2.2	-	2.8
Other factors	3.3	3.1	4.5	2.8
Avg. Total Losses	20.9	22.2	32.8	26.4
	21.5		29.6	

Table 3. Frequency and costs for aerial and ground applications on fall and spring lettuce in the 2004-2005 and 2005-2006 growing seasons

Insecticide Applications	Fall Lettuce		Spring Lettuce	
	<i>2004-05</i>	<i>2005-06</i>	<i>2004-05</i>	<i>2005-06</i>
Aerial application				
% acres treated	92.5	88.9	98.8	87.3
No. applications	3.4	3.2	3.5	2.5
Cost (\$) / application	8.88	8.37	9.65	8.45
Ground application				
% acres treated	93.1	90.6	91.8	92.7
No. applications	2.2	2.3	2.1	2.4
Cost (\$) / application	15.20	13.53	15.60	13.53

Table 4. Insect management costs for aerial fall and spring lettuce in the 2004-2005 and 2005-2006 growing seasons

Insect Management	Fall Lettuce		Spring Lettuce	
	<i>2004-05</i>	<i>2005-06</i>	<i>2004-05</i>	<i>2005-06</i>
% acres scouted	100	100	100	100
No. field vests/wk	3.4	4.1	2.8	3.0
Cost (\$) / acre	21.11	24.50	20.89	24.50

Table 5. Insect losses and control costs on fall head lettuce in the 2004-2005 and 2005-2006 growing seasons

Pest	Fall Head Lettuce							
	2004-2005				2005-2006			
	Treated Acres (%)	Foliar Insecticide Applications (No./ac)	Control costs (\$/ac)	Yield loss (%)	Treated Acres (%)	Foliar Insecticide Applications (No./ac)	Control costs (\$/ac)	Yield loss (%)
Seedling pests	57.0	1.1	\$11.50	2.6	66.5	1.1	\$14.50	0.8
Flea beetles	32.1	1.2	\$14.40	0.9	44.6	1.1	\$14.00	1.0
Leafminer	7.5	1	\$24.50	0.0	4.5	1.4	\$36.00	0.2
Beet armyworm	94.0	3.6	\$30.90	2.3	95.7	3.6	\$31.70	1.0
Cabbage looper	98.3	3	\$27.80	1.1	93.2	2.9	\$31.40	0.9
Corn earworm	41.0	1.8	\$24.20	0.4	52.3	1.6	\$31.80	0.4
Whiteflies	76.5	1.5	\$29.30	0.6	26.9	1.4	\$42.20	0.6
Green peach aphid	12.1	1	\$31.00	0.3	6.9	1.1	\$28.30	0.3
Foxglove aphid	0.1	0	\$0.00	0.0	3.1	1.1	\$28.00	0.1
Lettuce aphid	0.0	0	\$0.00	0.0	1.6	1.3	\$36.30	0.1
Thrips	36.0	1.4	\$26.40	0.5	38.8	1.4	\$29.90	0.4
Trash bugs	28.0	1.3	\$19.20	0.1	38.5	1.3	\$13.20	0.3

Table 6. Head lettuce insect losses and control costs on spring head lettuce in the 2004-2005 and 2005-2006 growing seasons

Pest	Spring Head Lettuce							
	2004-2005				2005-2006			
	Treated Acres (%)	Foliar Insecticide Applications (No./ac)	Control costs (\$/ac)	Yield loss (%)	Treated Acres (%)	Foliar Insecticide Applications (No./ac)	Control costs (\$/ac)	Yield loss (%)
Seedling pests	29.0	0.9	\$12.90	1.4	37.9	1.1	\$11.70	0.4
Flea beetles	5.0	0.9	\$13.45	0.8	14.9	0.9	\$13.50	0.4
Leafminer	0.0	0	\$0.00	0.0	1.5	1.5	\$36.90	0.0
Beet armyworm	54.0	1.7	\$30.90	1.0	55.2	1.5	\$31.80	0.5
Cabbage looper	73.0	1.9	\$26.00	1.1	65.4	1.5	\$30.90	0.7
Corn earworm	23.0	1.2	\$25.30	0.3	34.9	1	\$29.90	0.4
Whiteflies	12.0	0.8	\$14.00	0.1	7.1	1	\$35.00	0.0
Green peach aphid	56.0	2.2	\$25.00	1.1	61.1	1.9	\$33.80	1.2
Foxglove aphid	14.0	1.4	\$26.30	0.5	21	1.6	\$34.30	0.5
Lettuce aphid	2.0	2	\$26.30	0.0	6.8	1.9	\$37.90	0.4
Thrips	86.0	2.5	\$28.10	1.7	77.6	2.2	\$31.80	0.6
Trash bugs	29.0	1.6	\$19.20	0.1	45.2	1	\$13.20	0.3

Table 7. Frequency and costs of chemigation and soil-applied insecticides at stand establishment on fall head lettuce in the 2004-2005 and 2005-2006 growing seasons.

Treatment	Fall Head Lettuce			
	% Treated acres		Cost \$ of one application/acre	
	2004-05	2005-06	2004-05	2005-06
Chemigation treatments used at stand establishment	65.3	78.3	12.60	11.50
Soil applied insecticide used (Admire)	66.0	80.1	64.10	57.85

Table 8. Frequency and costs of chemigation and soil-applied insecticides at stand establishment on spring head lettuce in the 2004-2005 and 2005-2006 growing seasons.

Treatment	Spring Head Lettuce			
	% Treated acres		Cost \$ of one application/acre	
	2004-05	2005-06	2004-05	2005-06
Chemigation treatments used at stand establishment	52.0	47.4	14.55	11.00
Soil applied insecticide used (Admire)	63.0	79.6	67.20	57.08

Table 9. Insecticide usage on fall and spring head lettuce in the 2004-2005 and 2005-2006 growing seasons

IRAC MOA Group	Product	Fall Head Lettuce				Spring Head Lettuce			
		2004-2005		2005-2006		2004-2005		2005-2006	
		Treated acres (%)	No. times applied (No./ac)	Treated acres (%)	No. times applied (No./ac)	Treated acres (%)	No. times applied (No./ac)	Treated acres (%)	No. times applied (No./ac)
1A	Lannate	47.3	2.3	54.1	1.6	38.7	1.9	67.4	1.7
1A	Larvin	0.0	0	0.0	0	0.0	0	0.0	0
1B	Diazinon - foliar	2.1	1	4.2	1.2	1.4	1	5.1	1.2
1B	Diazinon-chemigation	40.1	1	42.0	1	19.6	1	37.5	1
1B	Dimethoate	4.6	1	6.0	1.3	42.3	1.5	19.8	1.3
1B	Metasystox -R	0.0	0	0.3	1	3.0	1	0.0	0
1B	Orthene (acephate)	9.4	1	8.9	1	24.9	1.2	16.4	1.1
2A	Endosulfan	21.0	1.1	18.6	1.2	38.2	1.3	37.7	1.4
3	Pyrethroids- foliar	96.7	3.5	99.8	3.3	92.6	3.3	96.1	2.9
3	Pyrethroids-chemigation	50.1	1	56.9	1	34.4	1	43.7	1
4A	Admire	65.9	1	80.1	1	63.0	1	79.6	1
4A	Provado	0.0	0	1.8	1	24.1	1.4	7.2	1
4A	Assail	n/a	n/a	4.7	1	n/a	n/a	33.9	1.3
5	Success	94.7	2.8	97.6	2.6	88.4	2.2	89.2	2
5	Entrust	0.0	0	0.4	2	0.0	0	0.0	0
6	Proclaim	13.7	1.2	36.8	1	2.6	1	12.9	1
6	Agrimek	0.0	0	0.0	0	0.0	0	0.0	0
9B	Fulfill	8.6	1	1.0	1	20.0	1.1	13.9	1.1
11B	Bt (i.e. Dipel/Javelin)	2.3	1	0.4	1	2.2	1	0.8	1
18A	Intrepid	59.7	1.4	61.1	1.2	41.0	1.2	56.7	1.2
18B	Azadirachtin / Neem	0.0	0	0.0	0	0.0	0	0.0	0
22	Avaunt	18.9	1.2	27.6	1.1	4.2	1	14.5	1
23	Oberon	n/a	n/a	1.4	1	n/a	n/a	3.9	1