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Impact of Bagrada Bug on Desert Cole Crops: Seven Years After the Outbreak

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The Bagrada bug, *Bagrada hilaris,* became a major pest of cole crops in the fall on 2010. Widespread outbreaks of this invasive stinkbug pest were reported throughout the desert growing areas in September and October of that year. The resulting stand losses and yield/quality reductions to broccoli, cauliflower, cabbage and other *Brassica* crops were considered economically significant. In an attempt to document the impact of annual infestations, we have surveyed produce growers and PCAs from Yuma Co., Imperial Co., and Maricopa Co. on an annual basis since 2010 to estimate the severity of Bagrada bug on direct-seeded and transplanted cole crops, and the intensity of chemical management required to control it.

PCAs and growers were anonymously requested to estimate the fall acreage (August-November) they managed, and of those acres, the percentage where *Bagrada* populations were present, what percentage required insecticide treatments and how often. In addition, they were asked to estimate, the average percent stand losses and plant injury caused by *Bagrada* infestations. Finally, PCAs and growers were asked to list the insecticide products they found to be effective in controlling Bagrada adults when applied as either sprinkler chemigations or foliar sprays. Information was collected separately for direct-seeded (e.g. broccoli) and transplanted (e.g., cabbage, cauliflower) cole crops. In 2015 and 2016 , we asked for information specific to organic production, and the use of Nipsit seed treatments in conventional production. Table 1 shows the number of PCAs who participated in the surveys each year and the acres their estimates represented.

Table 1. Number of PCA/grower respondents and acreage estimated in Bagrada surveys, 2010-16.

Season	No. PCAs responding	Acres Estimated in Survey		
		Direct-seeded	Transplanted	Total
2010	17	9310	4610	13920
2011	13	6210	3450	9660
2012	19	6290	4595	10885
2013	21	7255	5435	12690
2014	19	6080	8080	14160
2015	20	6700	6400	13100
2016	22	4423	7985	12408

Impact of Bagrada Bug Based on Insecticidal Control

Since the initial Bagrada bug outbreaks in 2010 it is clear that this invasive stink bug has become an important, established pest on desert cole crops. However, based on seasonal population abundance studies of adults infesting non-treated broccoli plants at the Yuma Ag Center (Fig 1), bagrada bug infestations in 2016-17 were the lowest we've experienced since the pest first appeared in the desert. Furthermore, bagrada bug population abundance on non-treated broccoli plots have been consistently declining since 2013 (Fig. 2). Results from the PCA surveys also indicated that Bagrada populations were considerably lighter in the fall 2016. Prior to 2016, bagrada bug infestations were present on greater than 90% and 85% of the direct seeded and transplanted cole crop acreage, respectively (Fig 3). However, in 2016, the percentage of acreage treated for bagrada adults in direct seeded crops was less than 60% of the total acreage, and about 50% in transplanted crops. In both crops, PCAs treated a higher percentage of acres than where the pest was present. This reflects the preventative approach to bagrada management, even when population pressure is relatively light. This is not surprising given the importance of controlling bagrada infestations at stand establishment in order to reduce stand losses and plant injury. This is reflected as well by the proportionately large number of acres chemigated an average of 1.5 times since the initial outbreaks (Table 2). However, once sprinkler pipe is removed from the field, management for bagrada remained intensive where about >80% of the reported acres were sprayed an average of 2.2 times in direct seeded-crops and over 76% of transplanted crops were sprayed almost 2 times from 2010-2015. In 2016, the number of spray treatments (1.0) were down considerably for both direct seeded and transplants. When the number of chemigations and foliar sprays are combined, in 2016 PCAs treated fewer times for bagrada compared to the previous six years.

We're uncertain why populations have been declining over the past few years, but may in part be a due to aggressive preventative control measures (particularly from 2010-2014), use of insecticide seed treatments, changes in the cropping system (fewer cotton acres) and/or drought conditions. Collectively, these management and environmental factors may have provided areawide population suppression both during the produce season as well as during the summer months when bagrada must survive on alternative wee and crop hosts.

Impact of Bagrada Bug Based on Crop Losses

Estimates of stand losses from bagrada bug infestations at stand establishment in both direct-seeded and transplanted crops has decreased over the past 7 years (Table 3). Stand losses in 2016 were quite low relative to the previous years. Feeding injury, defined as plants with multiple heads, forked terminals, and/or blind terminals resulting from Bagrada feeding, was comparable to 2015, in directed seeded crops, but considerably lower in transplants. Overall, total losses in both direct seeded and transplanted crops were lower than in any previous year, and down significantly compared with the initial outbreaks in 2010. The percent plant damage has also been lower in transplanted crops and suggests that newly, hardened transplants may withstand feeding injury better during stand establishment, and further suggest that injury occurring in cole crops is most important on very young seedlings (i.e., cotyledon-2 leaf plants). These reported losses are consistent with stand losses and plant injury measured in trials conducted at the Yuma Ag Center over the past seven years.

Organic Production

In 2016, four PCAs reported estimates from 100 ac of direct seeded and 775 ac of transplanted cole crops (cabbage, cauliflower and broccoli). In transplants, Bagrada was present on 56% of the acers, where 29% were treated via chemigation and 21% were treated via foliar sprays. It was estimated that the 0.6% of the organic crops reported on suffered stand losses and 2% of the crop suffered from plant injury. Damage estimates were down significantly from 2015 where stand losses

and plant injury in organic crops exceeded 10%. Pyganic was the only product listed for chemigation and a combination of Entrust +M-Pede, Azera, Pyganic, and Trilogy was used for foliar sprays.

Effective Insecticides:

Over the past 7 years, growers and PCAs reported using pyrethroids almost exclusively to control Bagrada bugs during stand establishment via sprinkler chemigation (Figure 4). Among the insecticide active ingredients (AI) reported as effective, bifenthrin (Brigade, Sniper, Hero and Discipline) was the most commonly reported, followed by lambda-cyhalothrin (Warrior II, Lambda-Cy) and zeta-cypermethrin (Mustang, Hero). Several other pyrethroids were reported as being effective including esfenvalurate (Asana), permethrin (Perm-Up), and beta-cyfluthrin (Baythroid) but were used by relatively fewer PCAs. One PCA reported using imidacloprid (Alias) in 2010, but since then no use of this AI has been reported. In 2013 and 2014, PCAs reported using Endigo, an in-can mixture of thiamethoxam and lambda-cyhalothrin, but none has been reported since 2014. In general, comments provided on the survey suggested that pyrethroid chemigations appeared to provide effective knockdown control of adults, but under heavy Bagrada bug pressure re-application was often necessary after 2-3 days.

In contrast, a broader array of AIs was reported for use against *Bagrada* when applied as foliar sprays on established stands after the sprinklers were removed. Pyrethroids were reported as the most effective chemistry used by PCAs (Figure 5). Bifenthrin was the most commonly used AI, followed by lambda cyhalothin, zeta-cypermethrin, and esfenvaluate. Among the alternative chemistries used, dinotefuran, methomyl and chlorpyrifos were reported to be effective against Bagrada adults by several PCAs, and a number of neonicotinoids, and pyrethroids were reported less frequently. Reports of neonicotinoid usage for Bagrada control decreased in 2016 consistent with fewer spray reported (Table 2). These estimates are consistent with results from efficacy trials conducted at Yuma Ag Center where products that have contact activity (i.e., Pyrethroids, OP/Carbamates) have provided the most effective control against Bagrada adults on both direct-seeded and transplanted cole crops.

Nipsit Treated Seed

We asked PCAs and growers about their experiences i with the newly registered insecticide seed treatment for broccoli, NipsIt (containing clothianidin). Several PCAs reported using Nipsit and the percentage of acreage planted with the seed treatment accounted for 41 and 66% of the total direct seeded-broccoli acers reported in 2015 and 2016, respectively (Table 4). Based on the performance rating criteria, PCAs reported that Nipsit provided good-excellent control of bagrada adults at stand establishment. In 2016, one PCA reported that the product provided good, cost-effective control, and several PCAs reported that using the product resulted in fewer foliar sprays needed for Bagrada control. These results are consistent with multiple years of research at YAC evaluating Nipsit broccoli against bagrada during stand establishement.

Acknowledgement

Special thanks go out to all the PCAs and growers who took time away from their busy schedules to participate in these surveys over the past seven years. Without your efforts, this data would not exist.

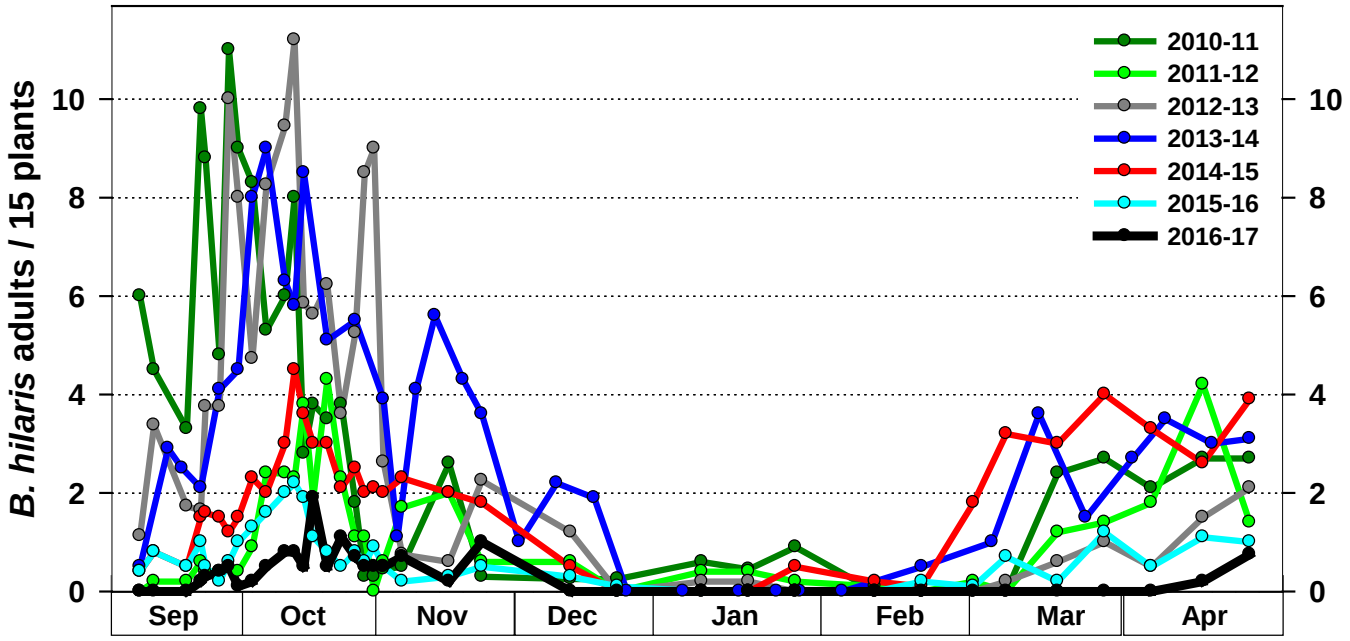

Figure 1. Seasonal Bagrada bug abundance (adults/15 plants) in non-treated broccoli at the Yuma Agricultural Center from September 2010 through April 2017.

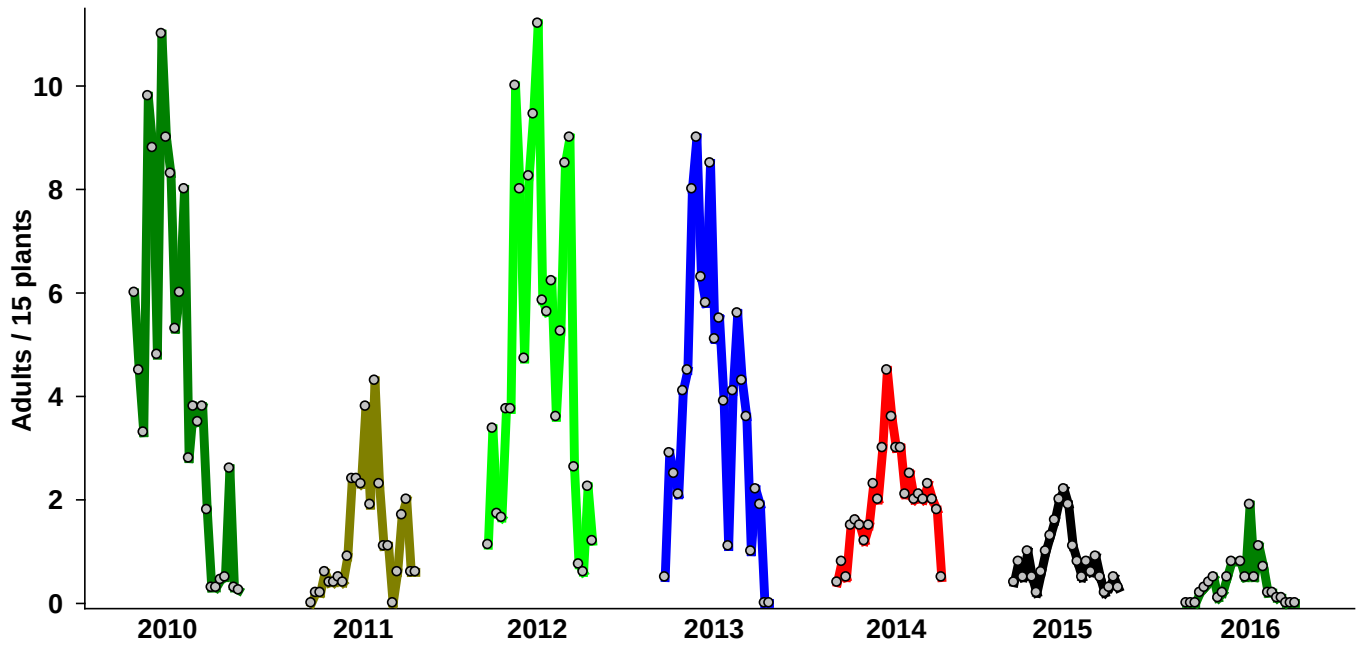

Figure 2. Fall Bagrada bug abundance (adults/15 plants) in non-treated broccoli at the Yuma Agricultural Center during Sep, Oct and Nov, 2010-2016.

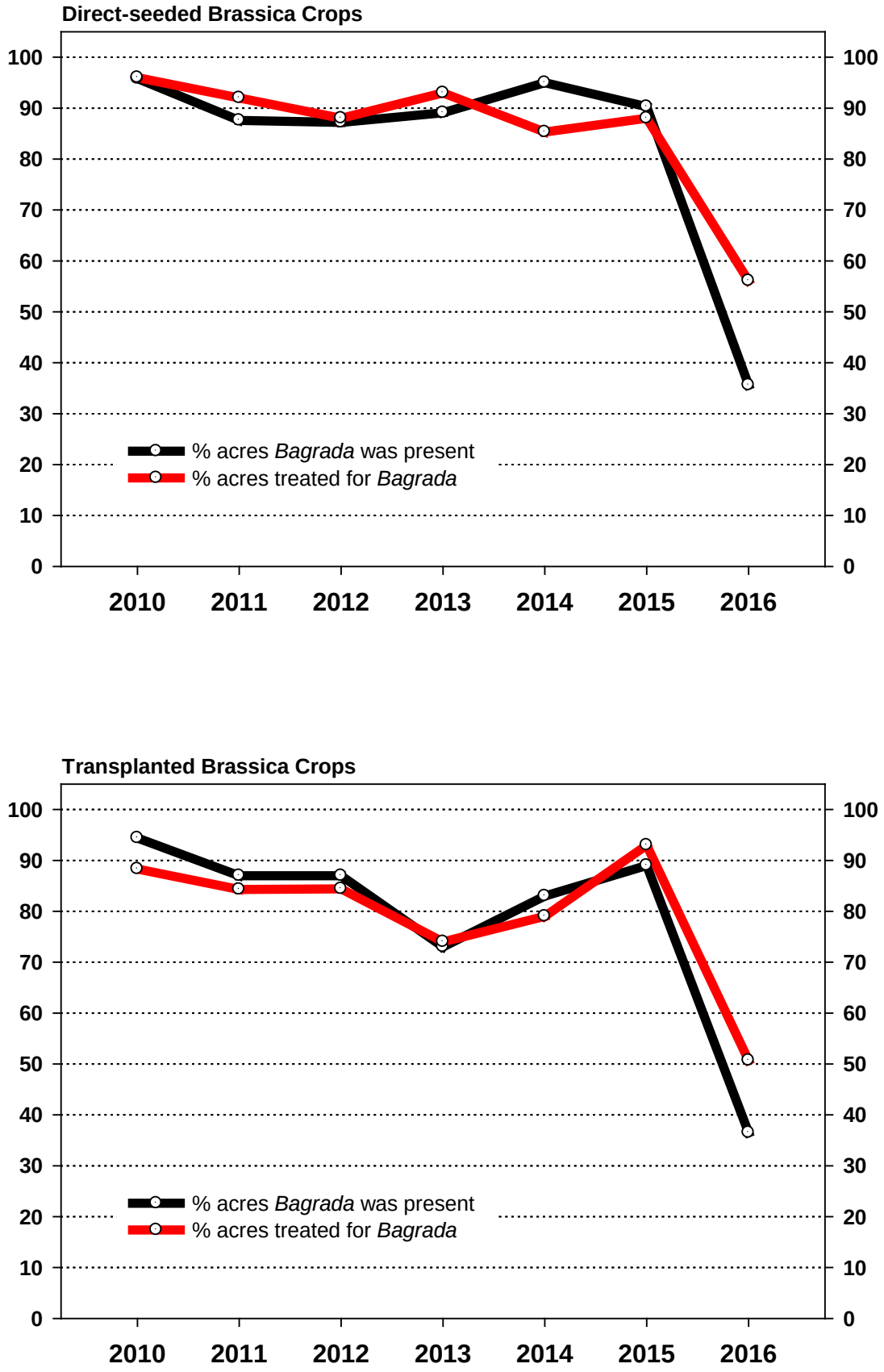

Figure 3. Percentage of acres where bagrada bugs were present and acres that required insecticide treatment for their control in direct-seeded (top) and transplanted cole crops, 2010-16.

Table 2. Impact of Bagrada bug on desert cole crops based on chemical control.

	Direct-seeded							Transplanted						
Chemical Control for *Bagrada*	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***
% acres **chemigated** with insecticide	73.8	75.2	85.5	87.1	75.6	85.9	52.3	60.6	72.0	65.1	67.4	64.8	79.3	55.1
Avg. no. of chemigations applied	1.6	1.6	1.6	1.5	1.6	1.3	1.2	1.4	1.3	1.1	1.3	1.4	1.3	1.0
% acres **sprayed** with insecticide	90.0	87.0	86.8	88.5	76.3	60.1	34.7	85.6	80.8	82.8	67.9	70.8	71.4	34.6
Avg. no. of sprays applied	2.7	1.8	2.5	2.5	2.2	1.4	1.0	2.1	1.8	1.8	1.9	1.5	1.8	1.0
Total avg. no. applications	4.3	3.4	4.1	4.0	3.8	2.7	2.2	3.5	3.1	2.9	3.2	2.9	3.1	2.0

Table 3. Impact of Bagrada bug on desert cole crops based on feeding injury.

	Direct-seeded							Transplanted						
Impact of Bagarada on Crops	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***
Avg. % stand loss	6.3	2.5	2.8	3.9	3.2	2.6	1.6	3.1	1.5	1.4	1.7	1.6	1.6	0.6
Avg. % plant injury	8.0	4.2	3.2	7.9	5.5	2.9	3.0	4.6	3.9	2.1	5.8	3.1	3.6	2.0
Avg. total % crop Loss	14.3	6.7	6.0	11.8	8.7	5.5	4.6	7.7	5.4	3.5	7.5	4.7	5.2	2.6

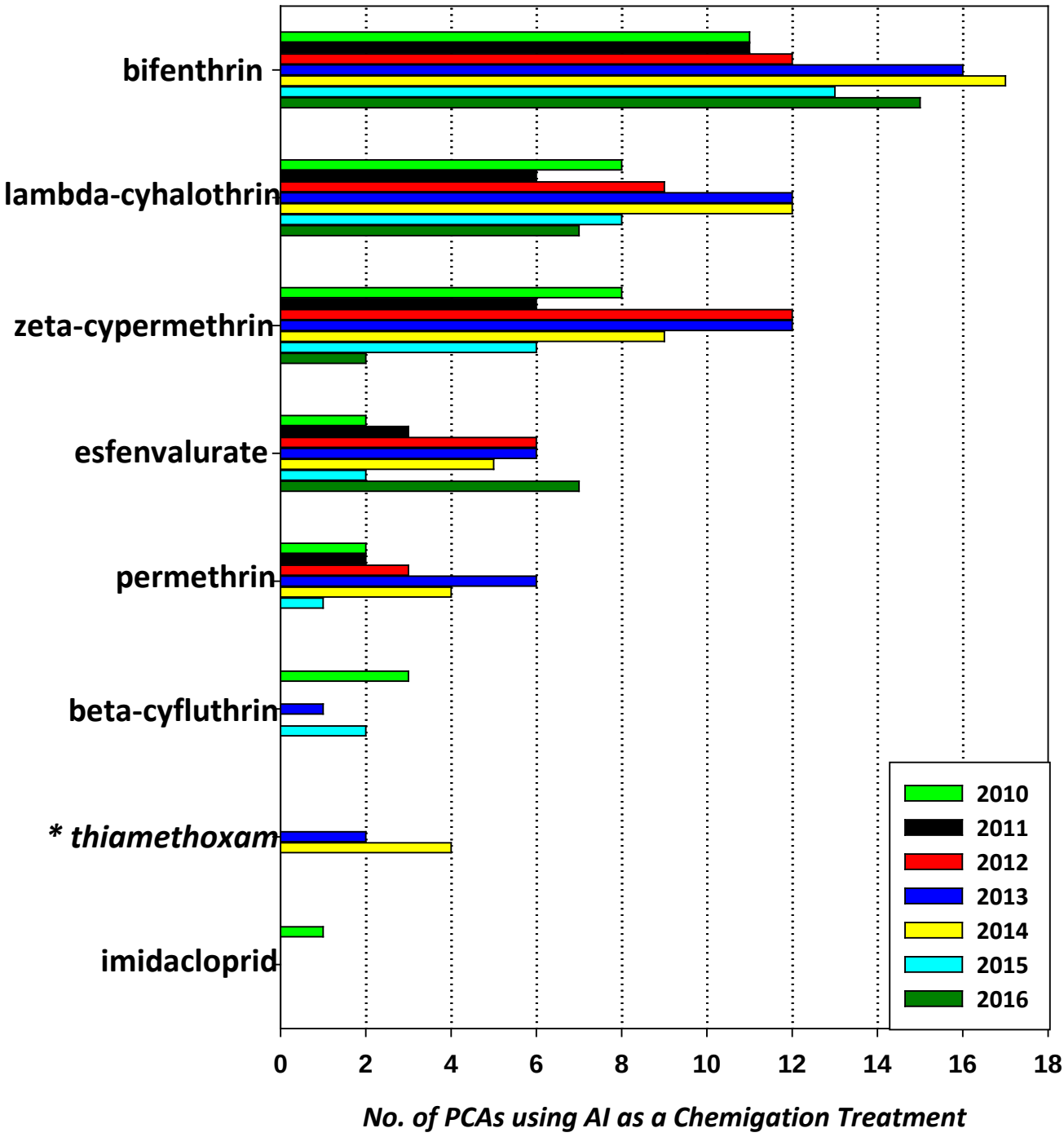

Figure 4. Insecticide AIs reported as effective against bagrada adult infestations when applied as chemigation treatments during stand establishment on cole crop fields in Yuma Co., Imperial Co. and Maricopa Co. in 2010-20165. * represents Endigo, a mixture of lambda cyhalothrin and thiamethoxam.

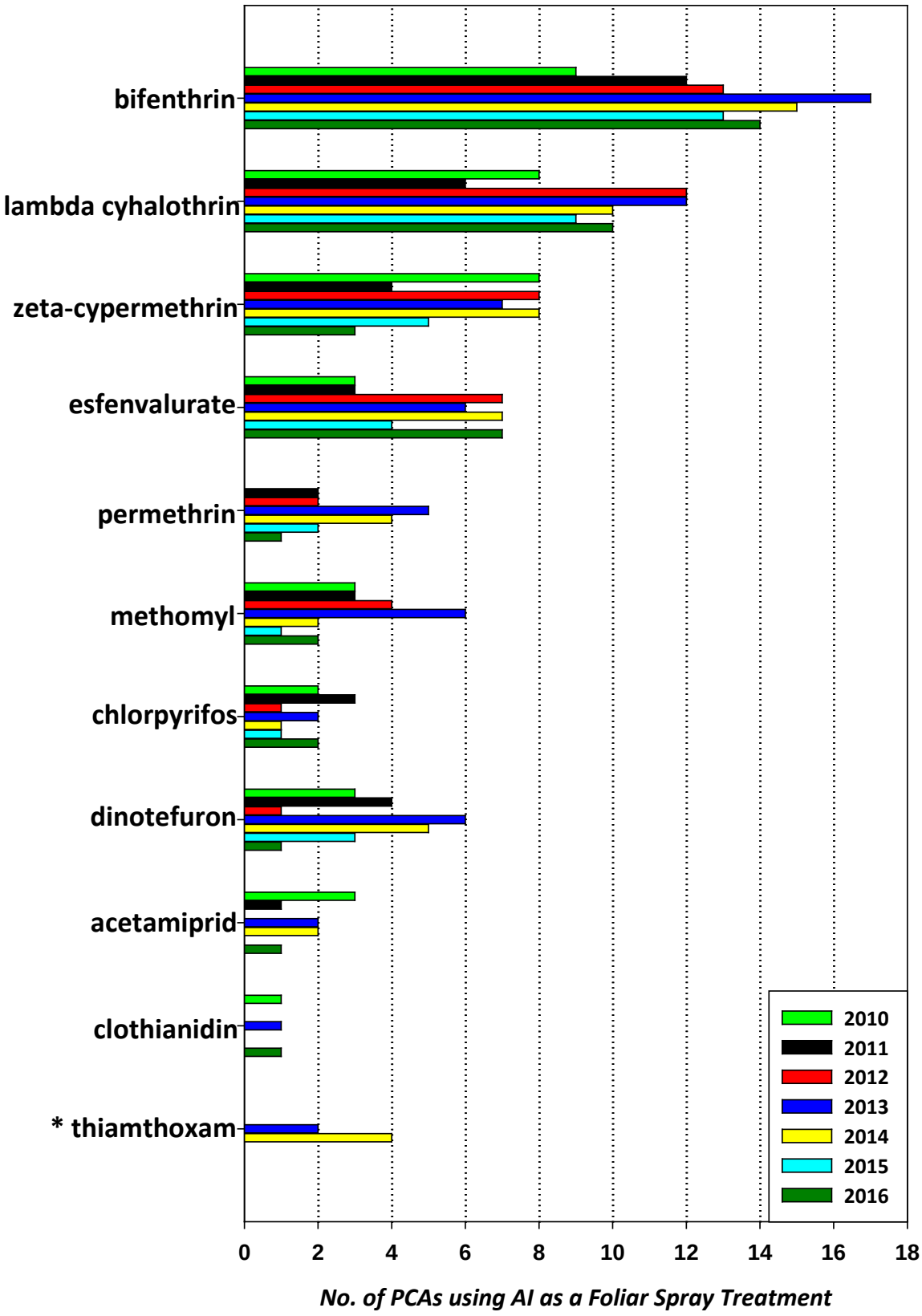

Figure 5. Insecticide AI s reported as effective against bagrada bug adult infestations when applied as foliar spray treatments on established cole crop fields in Yuma Co, Imperial Co. and Maricopa Co. in 2010-2016.
* represents Endigo, a mixture of lambda cyhalothrin and thiamethoxam.

Table 4. Estimated usage of Nipsit broccoli seed treatment (clothianidinn) and its performances against Bagrada bugs, 2015-16.

Season	No. PCAs using Nipsit	Acres planted with Nipsit	% of Total[1] Acres Reported	Performance[2] Rating
2015	8	2760	41.2	4.5
2016	7	2950	66.2	4.4

[1] Total acres of broccoli reported in 2015=6700; in 2016=4423.

[2] Rating based on a scale of 1-5; with 1=no control; 2= poor control; 3=fair control; 4= good control; and 5=Excellent control.