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Insect Losses and Management on Desert Lettuce: 2004-2016

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Introduction: The development of accurate data on the impact of insect pests on lettuce yield losses is important to the assessment of IPM programs in Arizona. Reliable estimates of yield losses caused by key insect pests occurring in lettuce is one of our most objective tools for assessing change in management practices. This information allows us to build relevant databases for measuring the pest status of important insect species found on desert lettuce, as well as the economic impacts they are responsible for. This information also serves as a resource to assist applied scientists in prioritizing research projects in developing IPM programs for desert lettuce. For PCAs, this data can demonstrate their efforts into economic terms for their growers, and justifies their value to the lettuce industry by showing the importance of insect pests in desert lettuce production. This summary over the past twelve-years (2004-2016) provides real world data on the pest status of key insect species, economics of insect management, and estimates of yield losses in lettuce.

Methods: 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 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:

First, Information was collected on the lettuce acreage represented by the respondents. Costs associated with aerial and ground applications and insect management fees for scouting were estimated. To provide data consistent with 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.

Second, Information was collected on IPM and crop insect losses through estimates of the % of acres where key insect pests were present and the % of acres treated with insecticide sprays aimed at the key insects. Included with those estimates are the frequency and costs of insecticide applications directed towards those insects. Overall, these costs represent an economic loss to the grower associated with preventing insects from damaging plants and reducing yields. Finally, actual percent yield losses (product not harvested due to insect damage or reduced quality) for individual insect species was estimated.

Finally, 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. This data has previously been summarized in the Insecticide Usage on Desert Lettuce, 2015-16 and can be found at the following site: https://cals.arizona.edu/crop/vegetables/advisories/more/insect159.html

Pest Status and Economic Yield Losses, 12-year Averages

Table 1 presents data on survey participation by local PCAs over the past 12 years. Surveys completed by PCAs represented a large proportion of the lettuce acres grown in Yuma, and neighboring Bard/Winterhaven growing areas (45-80% of total). Furthermore, the table reflects the large number of acres, that on average, PCAs scout and make management decisions on. The average number of sprays applied to lettuce and the associate cost of a spray application (aerial and ground averaged) costs are shown in this table. The estimated number of applications PCAs applied for insect management has averaged less than 5 over the past few years on both fall and spring lettuce. Not surprising, the surveys showed that annually 100% of the acres are scouted in both spring and fall crops. Scouting for lettuce pests in Yuma is also very intensive where lettuce fields during the fall and spring are in general visited >4 times per week. Finally, IPM scouting comes at a cost; average scouting fees were estimated to be greater than $20/acre over the past twelve years.

Table 2 presents a 12-year summary of data of the estimated pest status of insects and economic yield losses on fall lettuce. PCAs estimated that the Lep larvae complex (beet armyworm/cabbage looper/corn earworm) and Seedling, soil pests (beetles/crickets) are the most important economic pests on fall lettuce. On average, beet armyworm control required 3 applications at over $38/ acre and still resulted in average losses approaching 1%. This is clear documentation to the importance of this damaging pest. Cabbage looper and corn earworm often occur simultaneously with armyworms, but are not a prominent a pest. Although seedling soil pests were not treated on as many acreage as the Lep complex, they are still responsible for yield losses approaching 1%. A second group of pests that are important in fall lettuce is comprised of the Western flower thrips, flea beetles, and whiteflies. These pests are annually treated on greater than 40% of the acreage, and caused yield losses around 0.5%. Other pests such as aphids, grasshoppers and leafminers are of less economic importance on fall lettuce.

Table 3 presents a 12-year summary of data of the estimated pest status of insects and economic yield losses on spring lettuce. Western flower thrips has clearly been the primary pest on spring crops over the course of this survey, requiring the highest number of applications and spray costs and causing the greatest yield loss. The Aphids (green peach aphid, foxglove aphid and lettuce aphid) and Lep complexes were also major pests of spring lettuce. Among the aphid species, green peach aphid required the most economic management and responsible for losses in excess of 0.5%. In contrast, seedling pests, flea beetles and whiteflies were not as important on spring crops.

Note: Yield losses for any one pest never exceeded 1% in either fall or spring lettuce. It is commendable that PCAs and growers were capable of keeping insect losses to such low levels over a 12-year period. However, it is important to note that this was accomplished in part, by the considerable amount of time PCAs spend scouting for these pests at a $/acre fee, and certainly by the significant investment in insecticide sprays and applications costs used each season to prevent these key pests from causing economic damage to lettuce crops.

Seasonal Trends in Pest Status and Economic Yield Losses

Beet armyworm (BAW) - Figure 1.

BAW is the number one pest of fall lettuce in the desert. The fact that the % acres treated for BAW were often the same as the % acres where the pest was present is an indication how damaging this pest can be, particularly during the first 30 days of the growing season when plants are small. Thresholds for BAW control at this time are 1 larvae/100 plants, and control is more important in the fall when temperatures are ideal for BAW development and oviposition. Similarly, PCAs estimated they used almost twice as many sprays to control BAW on fall lettuce as opposed to spring lettuce. Estimates of yield losses have historically fluctuated over the years, and were particularly high in 2004 in both fall and spring lettuce, and losses in fall lettuce have steadily increased since 2011. This decline is likely due to the availability of a number of effective insecticides with extended residual activity, including soil applied diamides (eg., Coragen) that have been applied on average to 15% of the fall acres since 2009 (see *Insecticide Use Summary* for data).

Cabbage looper (CL) - Figure 2.

Similarly, CL is an important lettuce pest in both fall and spring lettuce. Like BAW, when CL was present in lettuce a very high percentage of the acres were treated. This is apparent for both fall and spring lettuce. In fall lettuce, trends in the % treated acres for CL have steadily decreased over the past 12 years, whereas the trend was much more variable in spring lettuce, likely varying with temperatures that occurred that season. Numbers of spray treatments for CL on fall lettuce were always higher than spray treatments applied to spring lettuce. Yield losses were highest in 2004, and have declined since then. However, losses have remained relatively stable at lower than average levels since 2011. This is also likely due to the availability of a number of effective insecticides with extended residual activity, including soil applied diamides.

Corn earworm (CEW) - Figure 3

CEW is an example of a pest that PCAs will treat preventatively. In several seasons, a greater % acres were treated than on acers where CEW was present. This occurs due to the potential for CEW larvae to cause unexpected heavy yield losses by contaminating heads at harvest (e.g., 2012 and 2014). Larvae are difficult to detect in the field because of their ovipositional patterns and their ability to quickly enter heads upon hatching. The prophylactic management of CEW on fall and spring lettuce was particularly evident the past few years where high yield losses were reported. Furthermore, the number of sprays for control of CEW was higher on spring lettuce than on fall lettuce the past two years. The trend in yield losses to CEW has increased since 2008. It is unknown why these heavy infestations have occurred recently, but may be a reflection of the increase of alfalfa production in the affected areas, particularly in Dome Valley, Wellton and Roll.

Seedling, Soil Insects (SSI) - Figure 4

The management of SSI often includes the use of sprinkler chemigation treatments with pyrethroids applied during stand establishment and are not reflected in this data. These treatments are important during the fall when crickets, beetles and ants can rapidly damage germinating seedlings in large area of fields. Insecticide use data indicates that on average, PCA chemigate for these pests on 70 and 30% of fall and spring acres, respectively (see *Insecticide Use Summary* for data). However, despite this, PCAs still treated for SSI with foliar applications an average of 1.2 times per season on fall and spring lettuce. These applications typically occur after sprinkler pipe used for germination are removed from the field. Yield losses have been consistently at, or below average, since 2010.

<u>Flea beetles</u> (FB) - Figure 5

FB is a good example of a lettuce pest where the presence of the pest on the crop does not necessary mean that PCAs need to control them. This is clearly illustrated by the data. Size of the crop will often determine the need for control. Small seedling lettuce plants (cotyledon-4 leaf stage) are very susceptible to FB feeding, whereas larger plant (> 4-leaf stage) can better tolerate low numbers of FB without economic damage. The number of treated acres and spray applications for FB have remained relatively steady over the years likely because FB is primarily a pest on young lettuce stands in early fall plantings. Incidence of FB on spring crops is much lower due to lower temperatures and lack of alternative host (cotton, alfalfa, summer annual weeds) that serve as a source of infestations. Yield losses attributed to FB have been below average since 2012.

<u>*Bemisia* whiteflies</u> (WF) - Figure 6

WF are another example where presence of the pest on the lettuce crop does not necessarily trigger spray treatments. Whiteflies are still considered a major threat to fall lettuce, but estimates show that less than 50% of the fall lettuce acers are treated with foliar sprays. However, it should be noted that about 75% of lettuce acers are annually treated with soil, at-planting applications of imidacloprid (see *Insecticide Use Summary*). When used at high rates (0.375 lb AI/ac), imidacloprid can provide residual control of WF during stand establishment up to 30 days. If pressure is still heavy after this time, foliar sprays are often necessary. Because of the use of imidacloprid at-planting, coupled with an average of 1.4 sprays per season on almost 50% of the acres, yield losses have remained low (<0.4%) for fall lettuce. Yield losses on spring lettuce have historically been less than 1% (often 0%) because populations are much lower in the spring.

<u>Green peach aphids</u> (GPA) - Figure 7

GPA is an important economic pest on spring lettuce, where the presence of aphid colonies on lettuce plants will trigger spray treatments. In some cases, PCAs will treat prophylactically with foliar sprays, particularly near harvest where even low aphid numbers on lettuce heads/hearts can cause the product to be rendered unmarketable. Similar to WF control, a little more than 70% of lettuce acers are annually treated with soil, at-planting applications of imidacloprid specifically for aphid management (see *Insecticide Use Summary*). Although imidacloprid will effectively control aphids, PCAs annually treat >65% of the acers >1.5 times per season to prevent contamination of spring lettuce at harvest. Yield losses to GPA has been trending downward since 2011, and may reflect the availability of effective insecticides with extended residual activity (e.g., Movento, Sequoia).

<u>Western flower thrips</u> (WFT) - Figure 8

WFT is emerging as one of the most important insect pests of both fall and spring lettuce. This has been evident the past few years where the % acres treated and the number of spray applications have been well above average. Since 2004 it has been present in, and treated for, on a large percentage of the spring lettuce crop (> 80%), averaging over 2 sprays per season. More recently, PCAs have reported a steady increase in treated acers for WFT on fall lettuce. In 2004 and 2005, PCAs reported they treated <40% of the fall acreage, whereas in 2015-16, greater than 80% of the acres were treated for WFT. This may in part be due to the increase in alfalfa acreage grown locally that serve as a source of WFT in the fall. This trend could also be a reflection of the increased usage of the diamide insecticides for Lep control that are not effective against WFT, as opposed to the OPs/Carbamates (acephate/methomyl). Yield losses to WFT have increased over the past several seasons, and losses have been above average on fall lettuce.

<u>Trash bugs</u> (TB) - Figure 9

TB are considered minor pests and are comprised of a number of plant bugs (false chinch bug, Lygus bug, stink bugs, three-corned alfalfa hopper) that are contaminants on lettuce at harvest. TB occur on a large percentage of the acers, but are treated on less than half of the acres where they are present. PCAs have consistently applied about 1.5 sprays per season for TB control. As a result, yield losses to TB have annually been minimal.

<u>*Liriomyza* leafminers</u> (LM) - Figure 10

LM were a major pest of lettuce in the late 1980's and early 1990's, almost uncontrollable until the Section 18 registration of Agri-Mek. LM would now be considered an occasional pest which requires minimal management, and has caused almost no yield losses in lettuce. This is likely due to the use of selective chemistry being used in lettuce in general that preserves the LM's natural enemies, and specifically the high usage of Radiant (spinetoram) and Coragen (chlorantraniliprole) being used for control of Lep larvae and thrips in fall and spring lettuce (see *Insecticide Use Summary*).

<u>Grasshoppers</u> (GH) - Figure 11

GH are a sporadic pest, but can be very damaging when they are abundant. We began collecting data in 2007 after a large number of GH occurred the previous fall season. In 2008, large outbreaks were reported on fall lettuce and caused considerable damage. Since then treated acres have varied from year to year, and yield losses has generally been minimal.

Table 1. Estimates of acers scouted by PCAs and the costs associated with applying insecticide sprays and scouting in lettuce.

Season	No. PCAs surveyed	Acres reported		Avg. no. sprays		Spray application cost ($)	Acres scouted (%)	No. field visits/week	Scouting fees/ac ($)
		Fall	Spring	Fall	Spring				
2004_05	16	19,760	14,210	5.6	5.6	12.45	100	3.4	21.11
2005_06	18	24,300	21,970	5.5	5.0	11.50	100	4.1	24.5
2006_07	13	18,370	14,180	4.7	4.5	13.25	100	4.0	22.2
2007_08	11	16,219	11,000	4.8	4.5	14.50	100	3.7	22.8
2008_09	12	18,340	16,100	4.6	4.4	15.15	100	4.0	22.5
2009_10	14	20,133	18,667	4.6	4.3	15.75	100	4.1	24.0
2010_11	18	24,342	20,380	4.4	4.3	16.80	100	4.2	23.1
2011_12	13	21,245	15,920	4.3	4.3	17.75	100	3.8	22.5
2012_13	15	18,350	16,180	4.5	4.2	19.10	100	4.3	23.4
2013_14	23	31,587	28,502	4.5	4.6	20.60	100	4.3	22.8
2014_15	19	26,904	27,255	5.0	5.1	23.10	100	4.1	23.6
2015_16	23	30,852	34,102	4.7	4.8	22.90	100	4.5	23.1

Table 2. Twelve-year summary of pest status, economic and yield losses to insects in fall lettuce.

	Fall Lettuce				
Pest[1]	**Acres pest present (%)**	**Acres treated (%)**	**No. of foliar applications**	**Chemical cost ($/ac)**	**Avg. yield loss (%)**
Beet armyworm	95.8	94.8	3.0	38.11	0.90
Seedling, soil pests	82.4	59.4	1.2	15.85	0.85
Cabbage looper	87.8	85.2	2.7	36.84	0.58
Flea beetle	61.3	39.4	1.2	16.76	0.55
Corn Earworm	54.0	51.9	2.0	35.37	0.48
Western flower thrips	86.0	59.6	1.7	36.98	0.48
Whitefly	81.4	47.4	1.4	36.58	0.42
Green peach aphid[1]	13.8	11.6	1.3	37.99	0.18
Grasshoppers	13.8	11.6	1.3	37.99	0.18
Trash bugs	64.3	27.4	1.4	18.82	0.10
Lettuce aphid	1.7	1.1	0.9	46.44	0.10
Leafminers	56.5	11.2	1.1	36.70	0.09
Foxglove aphid	2.9	1.6	0.8	43.14	0.08
Salt marsh Caterpillar	3.7	1.0	1.0	29.35	0.06

Table 3. Twelve-year summary of pest status, economic and yield losses to insects in spring lettuce.

	Spring Lettuce				
Pest[1]	**Acres pest present (%)**	**Acres treated (%)**	**No. of foliar applications**	**Chemical cost ($/ac)**	**Avg. yield loss (%)**
Western flower thrips	95.7	88.1	2.3	38.53	0.83
Corn Earworm	40.4	35.9	1.6	35.54	0.60
Green peach aphid	68.7	67.3	1.7	38.34	0.56
Cabbage looper	75.3	68.1	1.7	37.19	0.43
Seedling, soil pests	46.1	23.3	1.2	16.08	0.43
Beet armyworm	65.0	58.8	1.6	38.37	0.42
Foxglove aphid	13.9	16.4	1.4	37.68	0.28
Lettuce aphid	7.1	8.6	1.4	38.09	0.21
Flea beetle	24.7	12.8	1.1	17.18	0.20
Trash bugs	49.6	21.6	1.4	18.44	0.11
Whitefly	30.1	9.9	1.1	36.20	0.05
Grasshoppers	5.9	2.3	0.6	16.00	0.04
Leafminers	31.6	4.9	0.7	39.32	0.01
Salt marsh Caterpillar	1.1	0.1	0.3	35.00	0.00

[1] Does not include the cost of imidacloprid applications applied at-planting (12-year avg. of $29.55).

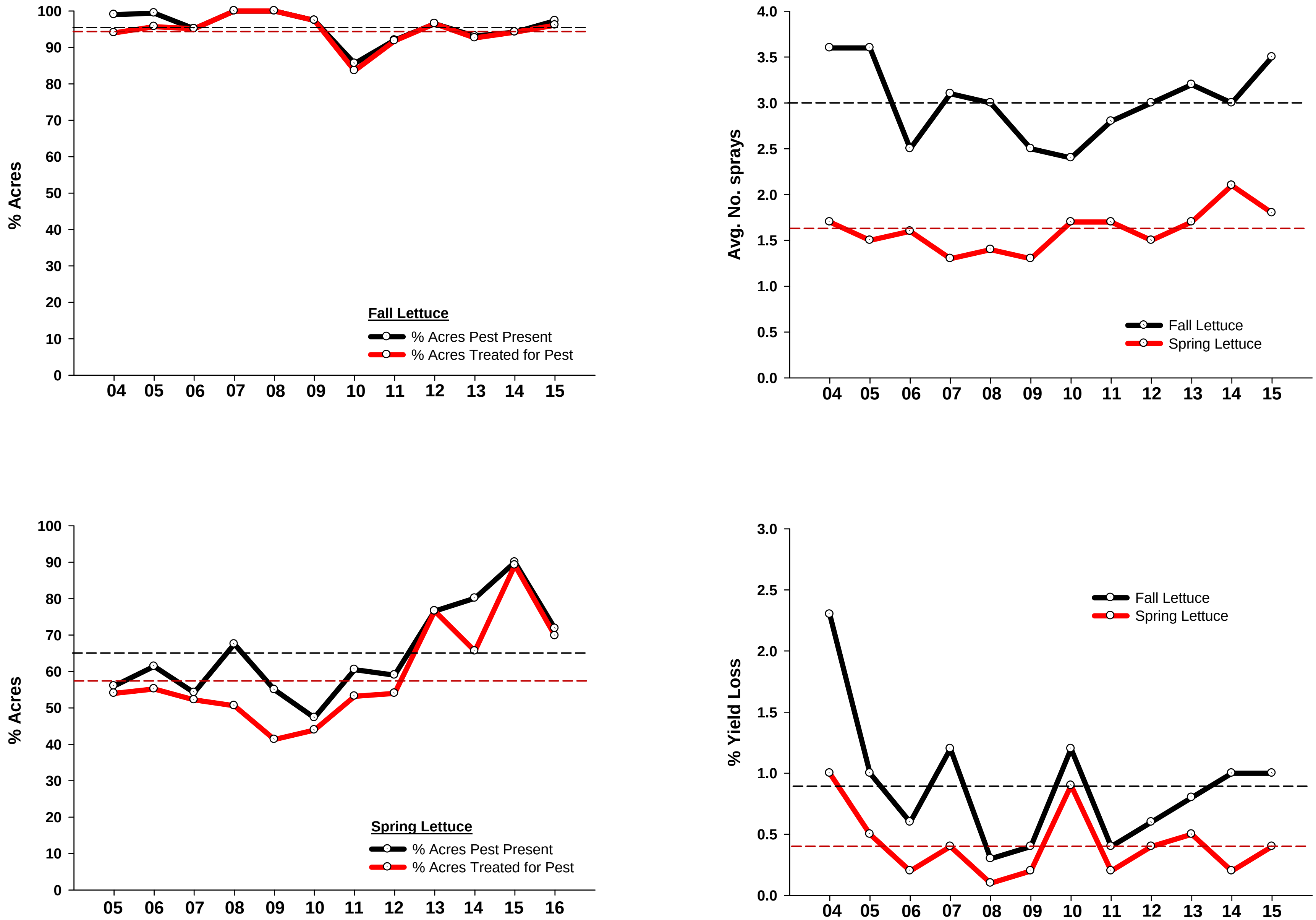

Figure 1. The % acres where **Beet armyworm** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to beet armyworm in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

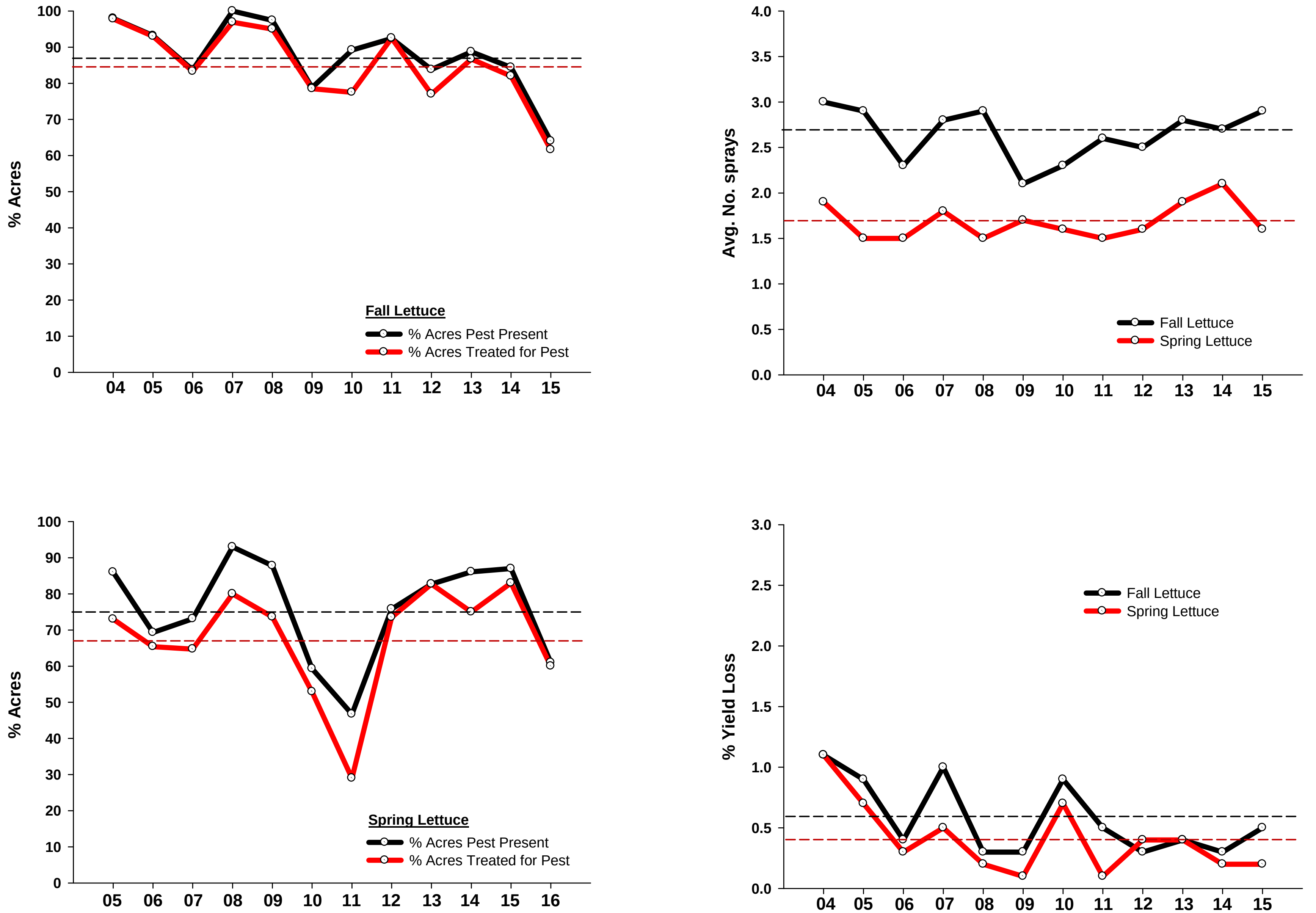

Figure 2. The % acres where **Cabbage looper** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to cabbage looper in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

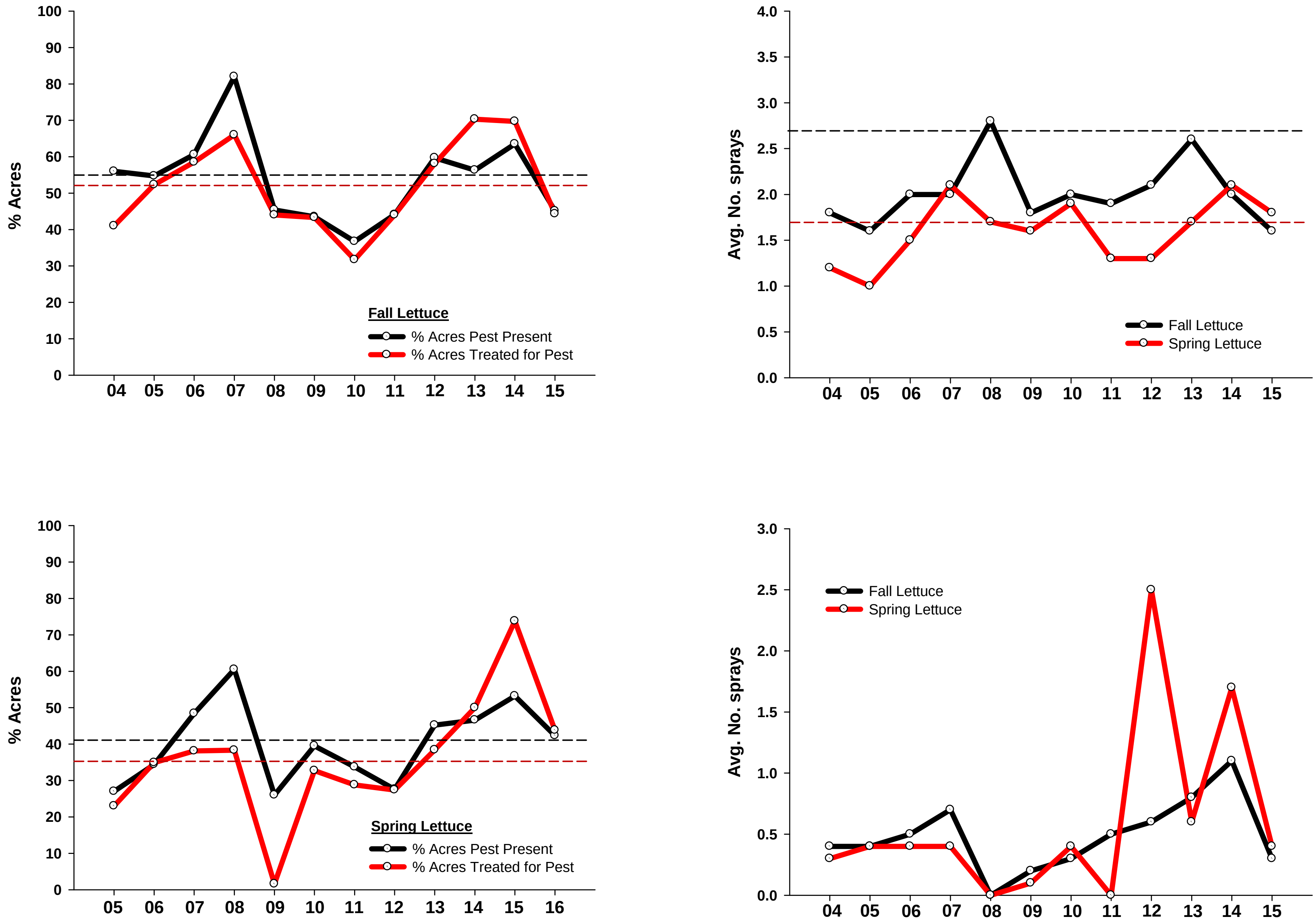

Figure 3. The % acres where **Corn earworm** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to corn earworm in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

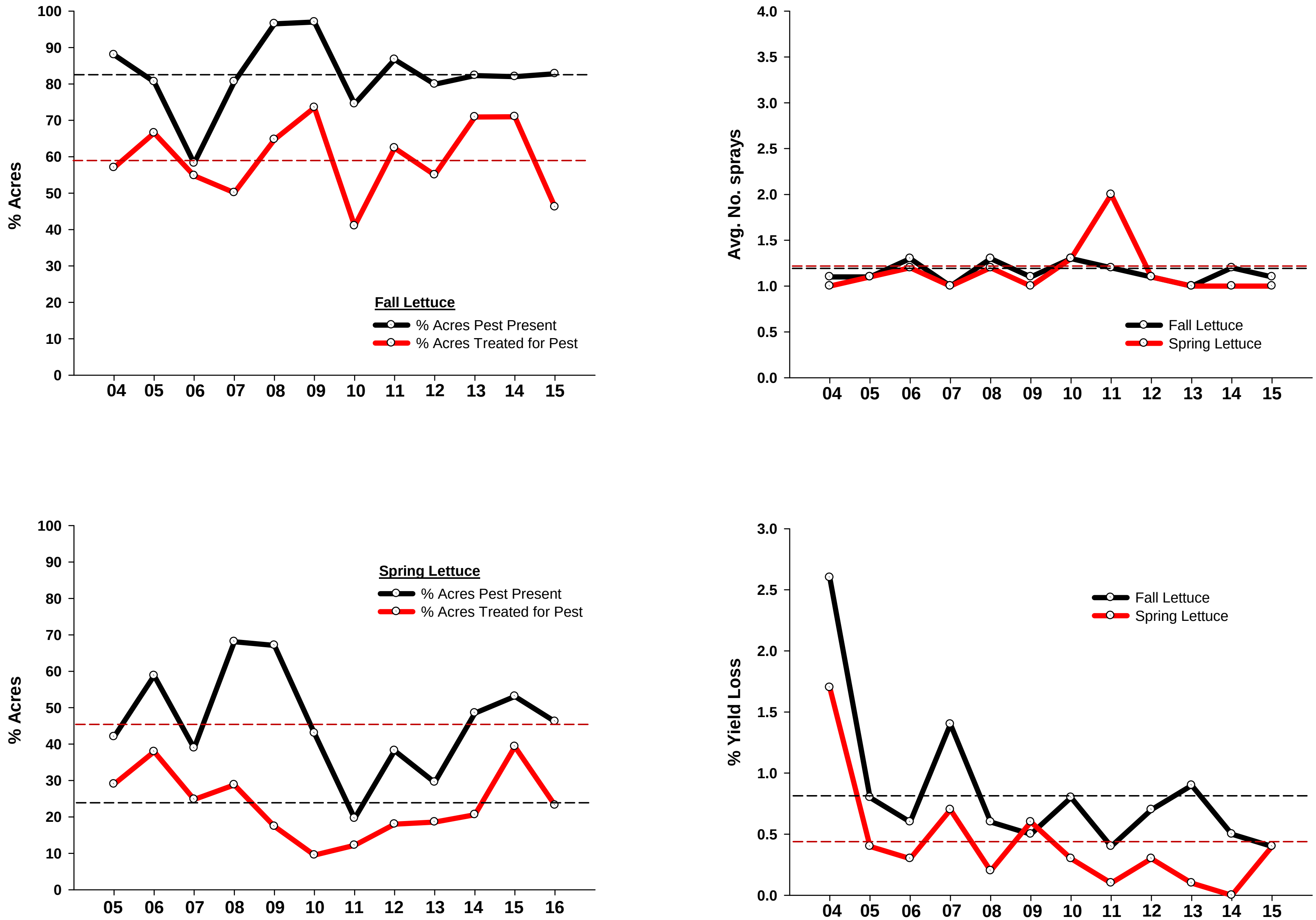

Figure 4. The % acres where **Seedling, Soil insects** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to seedling insects in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

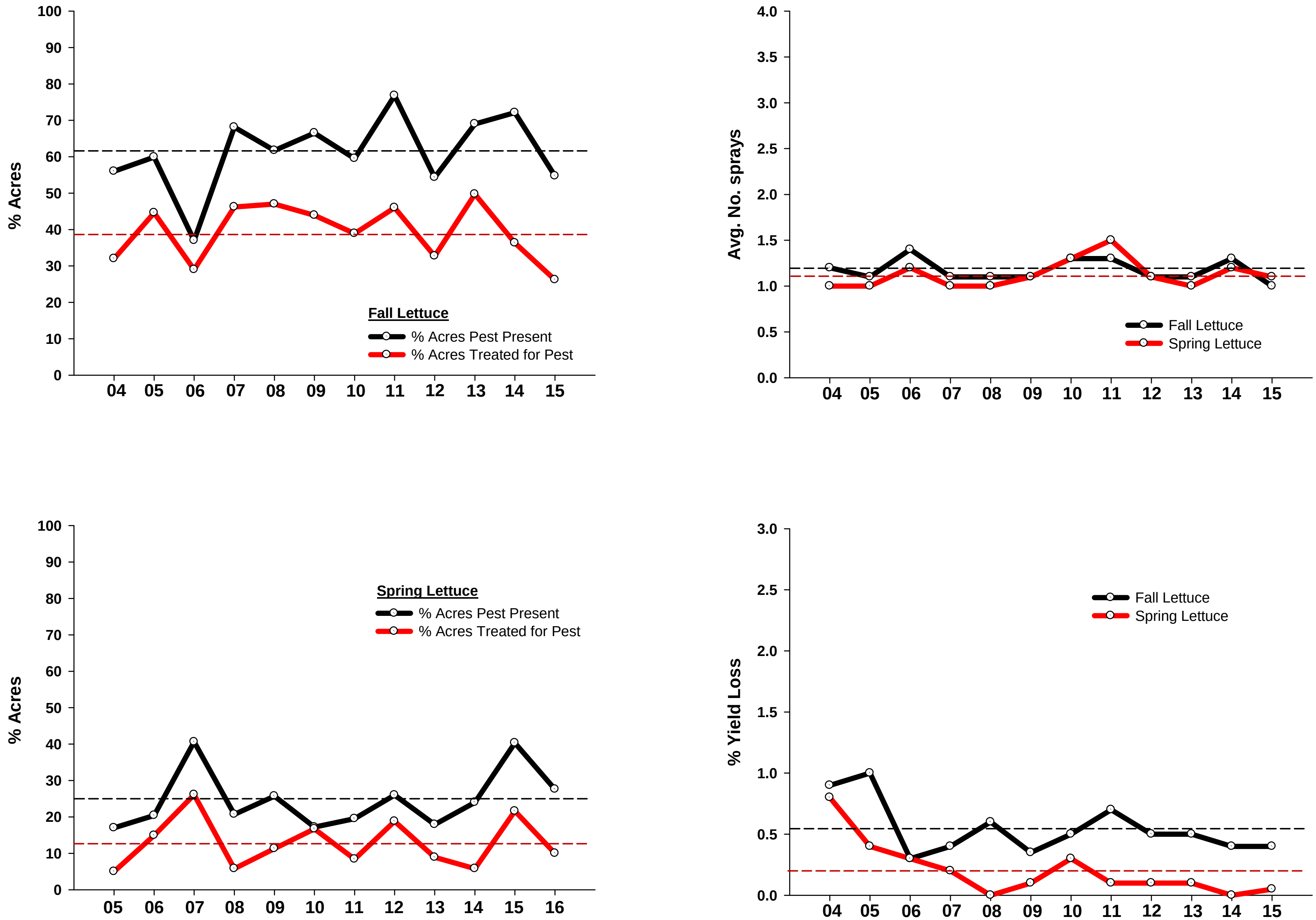

Figure 5. The % acres where **Flea beetles** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to Flea beetles in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

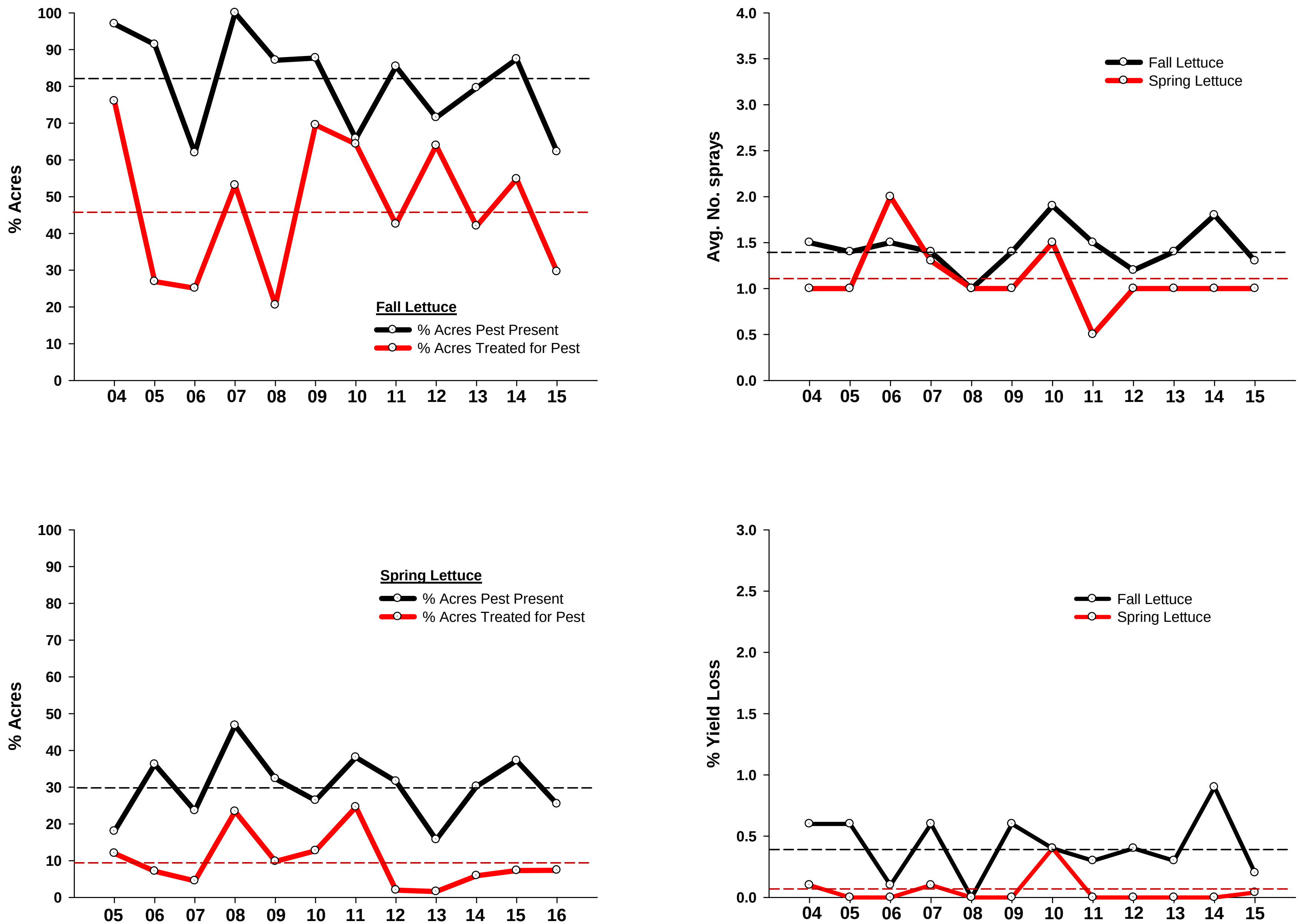

Figure 6. The % acres where ***Bemisia* whiteflies** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to *Bemisia* whiteflies in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

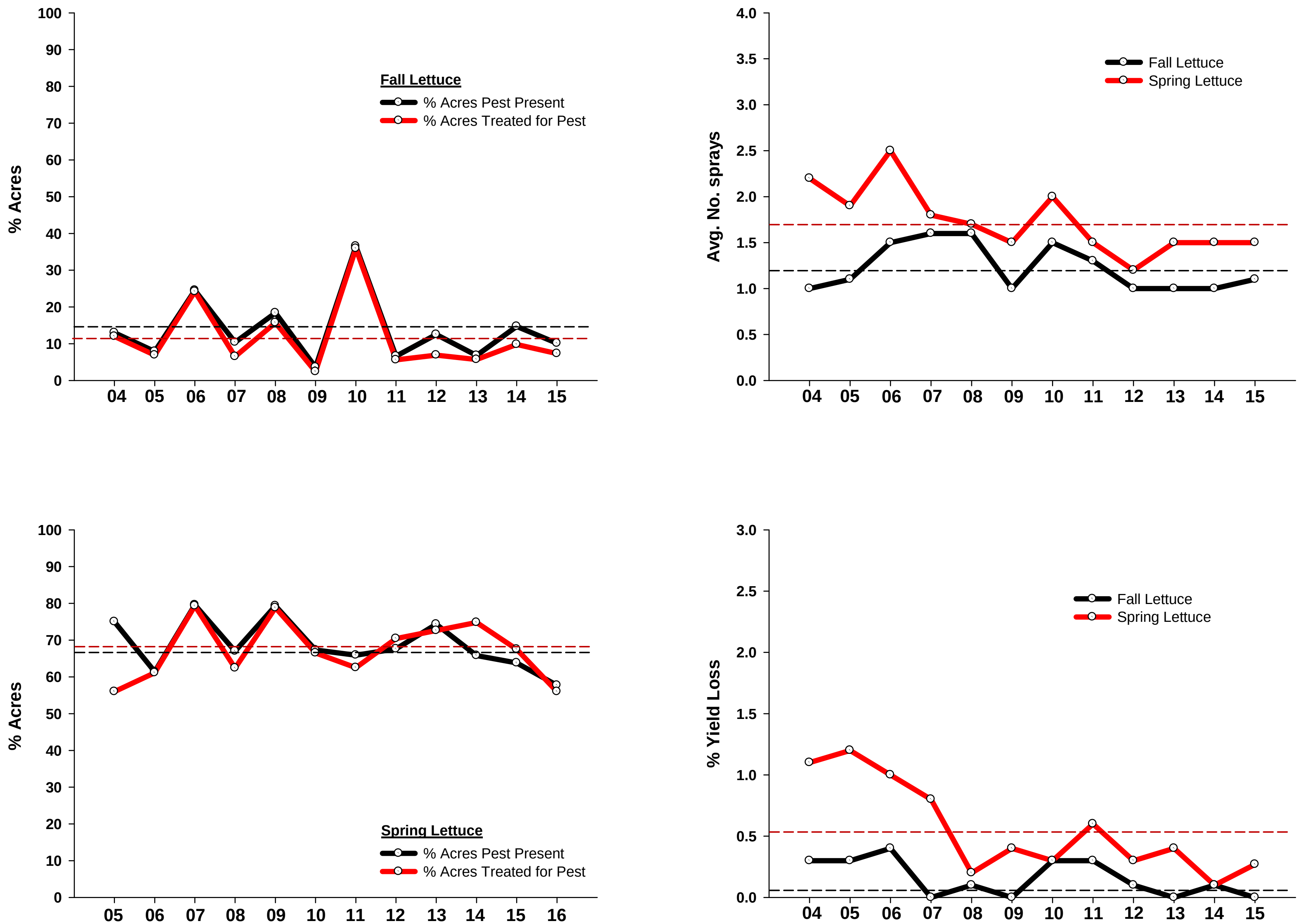

Figure 7. The % acres where **Green peach aphids** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to Green peach aphids in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

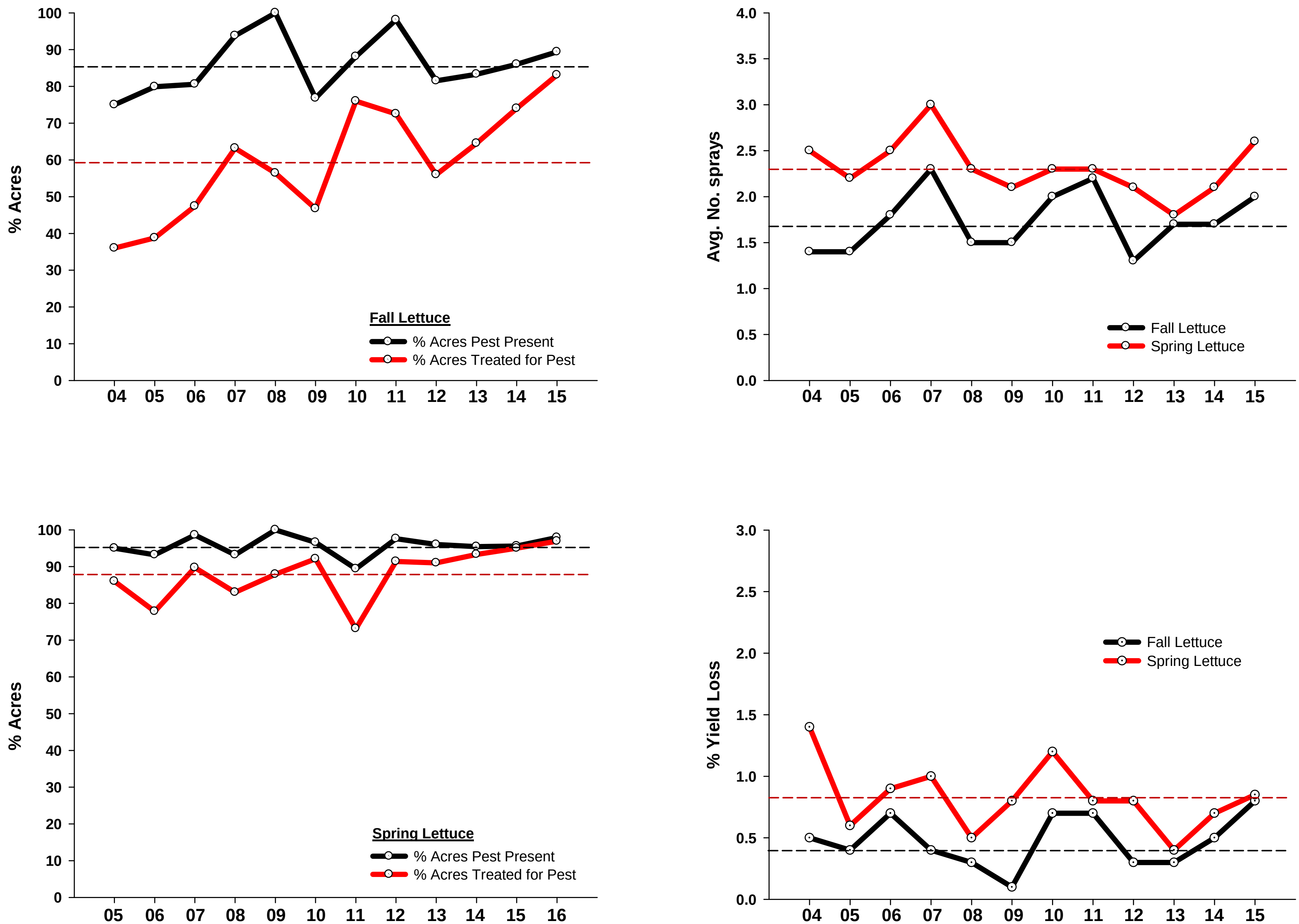

Figure 8. The % acres where **Western flower thrips** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to western flower thrips in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

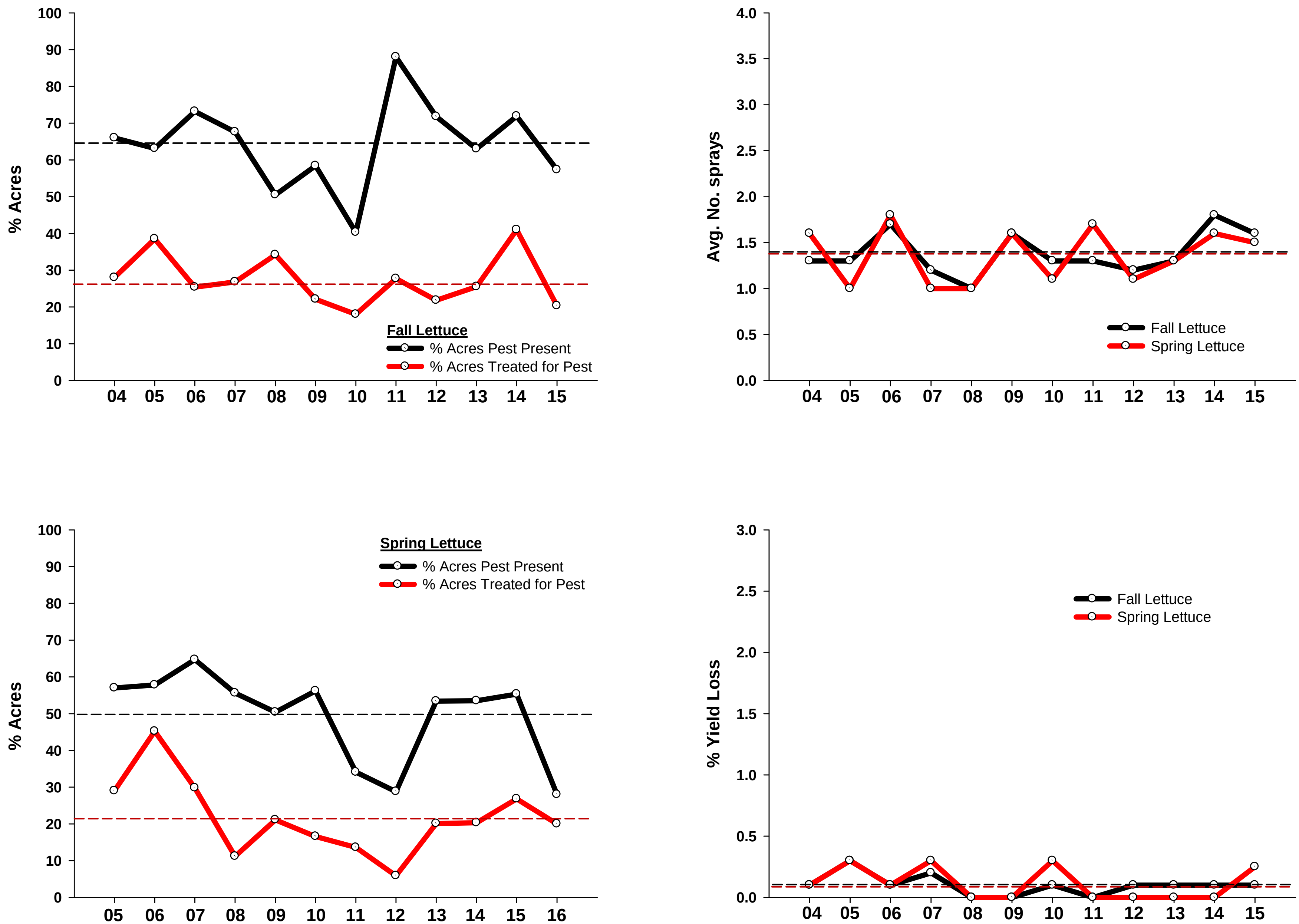

Figure 9. The % acres where **Trash bugs** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to trash bugs in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

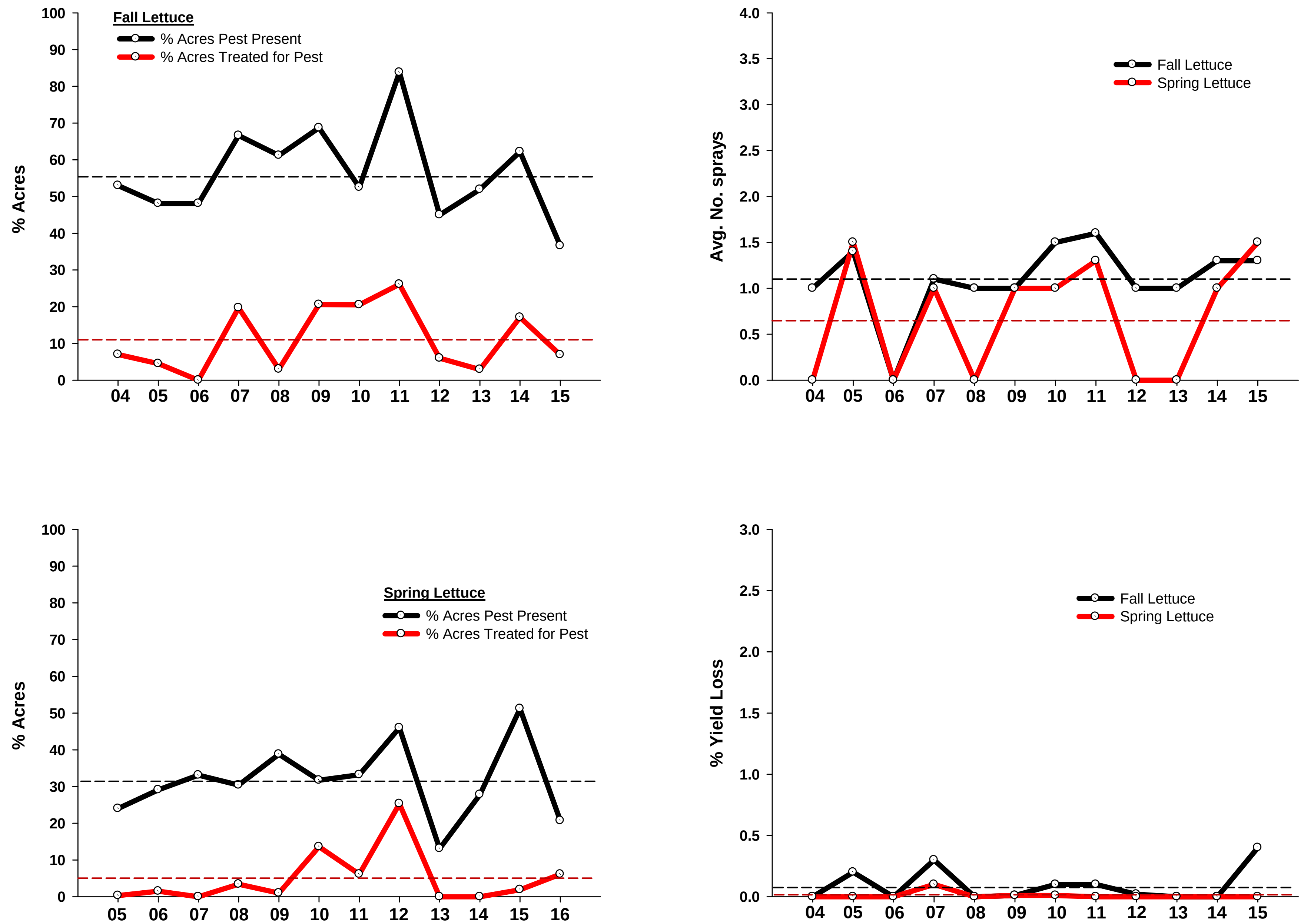

Figure 10. The % acres where ***Liriomyza* leafminers** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to *Liriomyza* leafminers in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.

Figure 11. The % acres where **Grasshoppers** were present and % acres treated for in fall lettuce (top, left) and spring lettuce (bottom, left); seasonal average no. sprays to control pest (top, right); and % yield loss due (bottom, right) to Grasshoppers in fall and spring lettuce, 2004-2016. Dashed lines denote 12-year average.