1990 ANNUAL REPORT TO CALIFORNIA ALMOND BOARD

Project No. 90-E4 - Ant Control in Almonds

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Objectives:

1. Continue studies comparing the effect of vegetation versus non-vegetation (on orchard floor) on ant damage to almonds.
2. Compare the effect of chemical treatments on ant species during different times of the year.
3. Experiment with different baits and repellents to keep ants away from nuts on the orchard floor.
4. Continue studies comparing the nut damage from different ant species.

1. We have completed the fourth and final year of the Almond Weed Management Trial (located in Kern County). The area of research has been the influence of various levels of cover crops on insect pest problems. Results are as follows regarding Southern Fire Ant:

   a. No significant difference in the number of ant colonies based on presence or absence of weeds.

   b. There is an indication colony size difference with smaller colonies being more prevalent in weed-free plots.

   c. Very low levels of damage were found in spite of high colony numbers. It appears that soil and air temperatures will influence the amount of damage while nuts are on the ground. This data has not been analyzed as of yet. Soil temperatures and air temperatures reach maximum at different times, which could completely inhibit ant foraging if these temperatures are sufficiently high enough. This fits quite well with the results of 1988 when damage differences were found based on weed management. Of the four years, 1988 was the only year where weed management affected damage. That was the year when drying temperatures were below 90°F--the activity threshold for fire ants. The remaining three years temperatures were well above 100°F. Finally, colony counts taken through the season show that numbers are greatest during April, May, June, and October and lowest during July, August, and September. Therefore, counts should be made in May and June to estimate populations. More complete information can be obtained from the Kern County UCCE office.

2. We selected an orchard with a Merced/Nonpareil/Nonpareil planting (in Fresno County) under low volume irrigation that had exhibited increasing amounts of ant damage during the past two years. Fire ant colonies were monitored and counted bimonthly from May until November except during harvest. In the past, ant activity (or number of mounds) and correlations with kernel damage has been difficult to measure. We investigated a number of items related to colony size, activity, and feeding.

a. Fire ants commonly developed mounds close to each other and "satellite" mounds which followed natural soil cracks. Does each mound constitute one colony for purposes of predicting future damage and determining treatment levels? We excavated a number of fire ant mounds and found workers and eggs down to three feet in depth. There were connecting tunnels (which contained ants) that extended at least two feet away from mounds. We then attempted to correlate kernel damage with the size of a colony. Our technique was placing a wooden stake at one end of the mound area and proceed to place subsequent stakes at one foot intervals from any other stake. The results from one trial are shown below . It appeared that colony size (as measured by surface area covered with mounds) can affect the percent damage to kernels.

% Almond Damage (Southern Fire Ant)

Nest Size (1-5 Stakes)		Nest Size (6-15 Stakes)		Nest Size (16+ Stakes)	
% Damage	Average %	% Damage	Average %	% Damage	Average %
46		91		44	
52		54		100	
21		92		89	
46		48		73	
	41.25		71.25		76.5

b. Fire ant activity as measured by number of stakes increased tremendously from May until right before harvest, as shown in Tables I through V. The numbers under the heading "Merced" refer to tree numbers within the row. The numbers listed underneath the headings No. (North) or So. (South) represent the size of individual colonies as the wetted areas were separated by six feet or more. This activity is summarized for the season in Graph 1. Fire ant mounds were found mostly on the wetted areas of the Merced rows, and less on the Nonpareil rows. The Merced trees are smaller and allow more sunlight on the ground surface. In addition, there was much ant activity in sites where missing trees occurred. Both observations suggest that fire ant mounds are sensitive to light as well as moisture. The eggs and larvae were found on the wetted edge of the micro-sprinkler irrigation, and usually located on the orchard floor and not the berm. The mound activity noted on the surface would adjust to different wetted patterns, and mounds would be dug along soil cracks that extended into dry soil. In addition, fire ants would develop mounds toward new food sources (like almonds placed nearby). Ant activity (or number of mounds) after harvest was extremely low after harvest and through December. This behavior contrasted with activity noted in the Kern County plot. After harvest ant activity was much greater on the berms than the orchard floor, and on both the Nonpareil and Merced rows. The presence of winged ants (or new queen ants) was noted from May through early December.

c. The treatment timing study will be started in early Spring. After harvest, the colony numbers and activity dropped to extremely low levels. It was felt that a Fall treatment would not yield significant results due to these observations. During 1990, the registration for Diazinon 14G was not renewed and was thus lost. The liquid formulation for Lorsban was given a federal (EPA) registration for ant control on almonds. The company is now pursuing a California registration. Our request to recognize a Lorsban soil treatment as legal on the present almond label was denied by CDFA.

3. a. One researcher spent time at Texas A & M University with entomologists working on the imported fire ant. That ant is closely related to the Southern fire ant causing problems in California. Due to those conversations, we started working with the insect growth regulator Logic, which is formulated for fire ant. In one of our field trials (data not analyzed yet), Logic required about five weeks before ant feeding was reduced on almonds placed near the colonies.

That was expected as the active ingredient kills the eggs and larvae, and stops the queen ant from laying eggs. The workers will still forage for food but are not replaced. Probably the most important observation was that most other ant species appeared to be repelled by the bait and would carry the bait away from their nests. That observation would not be unexpected as the percentage of active ingredient determines whether it is a repellent or attractant to different species. More field work is needed to gauge effects on other non-damaging ant species.

b. The indoor laboratories similar to ones established at TAMU were not operational yet. ICI chemicals donated a liquid "non-sticky" barrier which is needed to contain the ants within containers, but some problems occurred. We have conducted an extensive literature review, and there are numerous ideas to test under controlled conditions.

c. In addition, Dr. Harry Shorey (KAC) has joined our efforts. He is currently pursuing work with ant pheromones and baits. With his help, we are testing the effectiveness of different solutions containing sugar, honey, almond butter, soybean oil, etc. to attract ants and to monitor their activity. A post graduate student (biology-entomology) from CSUF is also working on the project.

4. Another ant, the Pharaoh ant (*Monomorium pharaonis)*, was found in almond orchards. Data is not completed on whether it causes economic damage. It builds mounds similar to fire ant, and workers will exit the nest when the ground is pounded like fire ants but to a much lesser extent. It is mostly red colored and can be polymorphic (different sizes within the same colony). We are continuing work on an in-depth survey of local almond orchards, noting the ant species present along with soil types, floor management, irrigation type, age/variety of tree, weed species, location of colonies, etc.

   b. We attempted to determine almond varietal susceptibility to fire ant damage. The percentage damage was compared to varietal shell seal for any possible correlations. There was too much interference with worm damage to make statistical correlations. There was a trend indicating more ant damage with poorer shell seal.

Summary and Future Direction

During this past year, we investigated a number of ideas about controlling ants in almond orchards. Much of the work this past year was observational or with limited trials (few replications) so we could first identify behavioral characteristics for possible control.

In past years, almond ant control consisted largely of applying granular or liquid chemicals before harvest to suppress or kill ants. Most growers ignored ants during the rest of the year. We have noticed more ant colonies in recent years, however. Ants, like many insects, can adapt and explode in population when the environment is favorable. Thus, it is probably unrealistic to use methods that would "eradicate" ants from the orchard. Besides, ants serve useful purposes such as feeding on other insects and tunneling through (or moving) soil. We have identified many ant species in almond orchards. Ants feed on many items, including insects, weed seeds, sugar, tree roots and young wood, etc. The fire (and pavement to a lesser extent) ant alone causes economic damage to almond kernels. The pyramid, harvester, thief, pharaoh, and field (Formica) ants prefer to feed on other sources. So, how can we selectively control fire ants without adversely affecting other ant species?

We must accurately identify fire ant nests and forecast potential damage. Much past work was done correlating the number of fire ant colonies with future damage. However, many fire ant colonies are hard to find and colony size will affect percent damage. We experimented with baiting or monitoring stations which consisted of 2 x 2 inch stakes and a plastic container on top containing a bait. Ant

activity can be measured by counting the number of ants passing a certain point. Almond kernels were the best attractant to date. We do not have correlations between ant activity and damage levels using this method yet.

We are investigating the effect of environment on ant damage. Fire ant activity (foraging) is suppressed by temperatures much above 90° F. However, there was no significant difference in numbers of ant colonies based on the presence or absence of weeds within a sprinkler plot (in Kern County). Cover crops should lower the ground temperature and thus allow more ant foraging. Under a micro-sprinkler system, the fire ant population exploded. Fire ant colonies need moist soil and seem to prefer more stable moisture conditions. Growers using low volume systems should monitor their orchards and almond grade sheets to check for increasing ant damage. The colonies also moved during the year in response to many factors. We are still evaluating possible cultural practices to control ant activity such as tillage.

Currently, there is not any chemical registered for California ant control in almonds which we would recommend. The Diazinon granular label expired. Lorsban and Logic (a granular growth regulator) were used in plots this past year. Lorsban suppressed ant damage for up to seven weeks while Logic suppressed ant damage starting in the sixth week. In addition, Logic appeared to repel (and not kill) some other ant species. If that observation holds up, Logic would be an ideal tool to selectively suppress fire ant. Both chemicals are presently not registered for ant control on almonds.

There were differences between levels of ant damage and almond varieties, but worm damage obscured any relationships. The varieties with poor shell seals (Nonpareil and Merced) had the most ant damage. This work needs to be repeated.

Table 1. Ant Colony Location And Size (# Stakes)

5/1/1990

SO.	MERCED 1	NO.	SO.	MERCED 2	NO.	SO.	MERCED 3	NO.	SO.	MERCED 4	NO.
	1			1	6		1			1	
	2			2	7		2	9		2	
	3	2		3	2	6	3		2	3	
	4		4	4	7		4			4	7
4	5			5	6		5	18		5	
	6			6			6			6	
	7		8	7	4		7	11		7	
	8		2	8	8		8			8	3
	9			9	5		9	8		9	2
	10	2		10			10			10	3
	11	15		11	3		11			11	5
	12	10		12		3	12			12	10
	13	6	3	13	3		13	5	2	13	3
	14	6		14			14			14	10
	15	8	7	15			15			15	5
2	16			16			16			16	2
	17	9	5	17			17		1	17	1
	18	15		18			18			18	6
	19			19	3		19	5		19	
1	20		5	20			20			20	14
1	21	8		21			21			21	1
	22	2	6	22			22			22	
	23	4		23			23			23	
	24			24	5		24	12	3	24	1
2	25	3		25			25	2	6	25	6
	26	4		26	19		26		8	26	6
	27	8		27			27			27	
	28	5		28			28			28	2
	29			29	6	2	29	5		29	15
	30			30			30			30	
	31	2		31			31			31	
	32			32	4		32			32	4
	33		4	33	4		33	6		33	3
	34			34			34			34	10
	35	15	3	35	1		35			35	
	36	5	2	36	10		36	6		36	
	37			37	2	18	37			37	
	38			38	10		38			38	1
	39			39			39	6		39	
	40			40	15		40			40	8
	41	5	6	41	10		41			41	8
	42			42	9		42			42	
	43			43			43			43	
	44			44	25		44			44	
	45			45			45			45	
	46	1		46	8		46	7		46	15
	47	2		47			47			47	
	48			48			48		10	48	
	49			49	9		49			49	
	50			50	9	13	50			50	
	51	5		51			51			51	
	52			52			52			52	
	53			53			53		2	53	
	54			54			54			54	
	55			55	2		55		2	55	
	56			56	3		56			56	
	57			57		3	57			57	
10	58	142	55	58	205	45	58	100	36	58	151

Total All Rows: 744

TABLE 2. ANT COLONY LOCATION AND SIZE (# STAKES)

5/24/90

SO.	MERCED 1	NO.	SO.	MERCED 2	NO.	SO.	MERCED 3	NO.	SO.	MERCED 4	NO.
	1			1	6		1			1	
	2			2	7		2	11		2	
	3	2		3	6	6	3		11	3	
	4		5	4	9		4			4	12
6	5	1		5	6		5	21	9	5	3
	6			6			6			6	3
	7		8	7	5		7	16		7	
	8	4	2	8	8		8			8	18
	9			9	5		9	11		9	11
	10	5		10			10			10	20
	11	17		11	3		11			11	17
	12	16		12		3	12			12	11
	13	6	3	13	3		13	5	2	13	3
	14	8		14			14			14	
	15	9	11	15			15	7		15	6
2	16			16			16	2		16	2
	17	10	11	17			17		1	17	2
	18	18		18			18			18	6
	19			19	3		19	7		19	
3	20	2	5	20			20			20	20
1	21	8		21			21			21	1
	22	2	9	22			22			22	
	23	5		23			23			23	
	24			24	6		24	12	3	24	1
2	25	8		25			25	5	7	25	8
	26	4		26	19		26		8	26	6
	27	11		27			27			27	
	28	5		28			28			28	4
	29			29	6	2	29	10		29	17
	30			30			30			30	
	31			31			31			31	
	32			32	4		32			32	5
	33		4	33	4		33	8		33	8
	34			34			34			34	11
	35	27	3	35	1		35			35	
	36	22	4	36	10		36	10		36	
	37			37	2	23	37			37	
	38			38	14		38			38	1
	39			39			39	10		39	
	40			40	17		40			40	8
	41	9	6	41	10		41			41	9
	42			42	11		42			42	
	43	1		43			43			43	
	44			44	25		44			44	
	45			45			45			45	
	46	2	4	46	8		46	7		46	15
	47	2		47			47			47	
	48			48			48		14	48	
	49			49	18	13	49			49	
	50			50	11		50	2		50	
	51	5		51			51			51	
	52			52			52			52	
	53			53			53			53	
	54			54			54		2	54	
	55			55	2		55		2	55	
	56			56	8		56			56	
	57			57		5	57			57	
14	58	209	75	58	237	52	58	144	59	58	228
									Total All Rows:		1018

TABLE 3. ANT COLONY LOCATION AND SIZE (# STAKES)

6/15/90

SO.	MERCED 1	NO.	SO.	MERCED 2	NO.	SO.	MERCED 3	NO.	SO.	MERCED 4	NO.
	1			1	6		1			1	
	2			2	7		2	16		2	
	3	8		3	12	10	3	6	17	3	
	4		11	4	14		4			4	12
10	5	4		5	6		5	35	12	5	
	6			6	11		6			6	3
7	7	3	11	7	8		7	26		7	
	8	14	5	8	15		8			8	23
	9			9	9		9	17		9	13
5	10	8	5	10	3		10			10	20
	11	17		11	21		11			11	20
	12	18	2	12		5	12			12	15
5	13	6	8	13	14		13	16	4	13	9
	14	8		14			14			14	
9	15	13	18	15			15	13		15	8
4	16	3		16			16	3		16	8
	17	18	21	17	7		17	7	3	17	6
	18	21	11	18			18			18	18
	19	3		19	13		19	12		19	
10	20	5	9	20			20		3	20	21
4	21	10		21			21			21	4
13	22	3	20	22			22			22	
4	23	11	1	23	4		23			23	
4	24			24	14		24	15	6	24	1
12	25	8		25	3		25	18	7	25	12
	26	15	1	26	27		26		8	26	18
	27	13		27	8		27			27	2
	28	5	3	28	16		28			28	4
	29		4	29	25	3	29	15		29	24
	30			30			30	3		30	2
	31	3		31		3	31	2		31	2
	32			32	7		32	12		32	20
	33		11	33	6		33	17		33	13
	34			34			34			34	27
	35	27	12	35	1		35			35	
	36	24	6	36	15		36	15	2	36	
	37			37	6	24	37		4	37	3
2	38			38	19		38			38	1
	39			39			39	12		39	
	40			40	23		40			40	8
	41	9	14	41	10		41			41	19
	42			42	11		42			42	
	43	1		43			43			43	
	44			44	25		44			44	
	45			45	3		45	2		45	
	46	2	4	46	8		46			46	20
	47	2		47			47			47	
	48			48			48		18	48	
	49			49	21	13	49			49	
	50			50	16		50	2		50	
	51	5		51		18	51		2	51	
	52			52			52			52	
	53			53			53			53	
	54			54	4		54		7	54	
	55			55	2		55		5	55	
	56			56	8		56			56	
	57			57		5	57			57	
89	58	287	177	58	428	81	58	264	98	58	356
									Total All Rows		1780

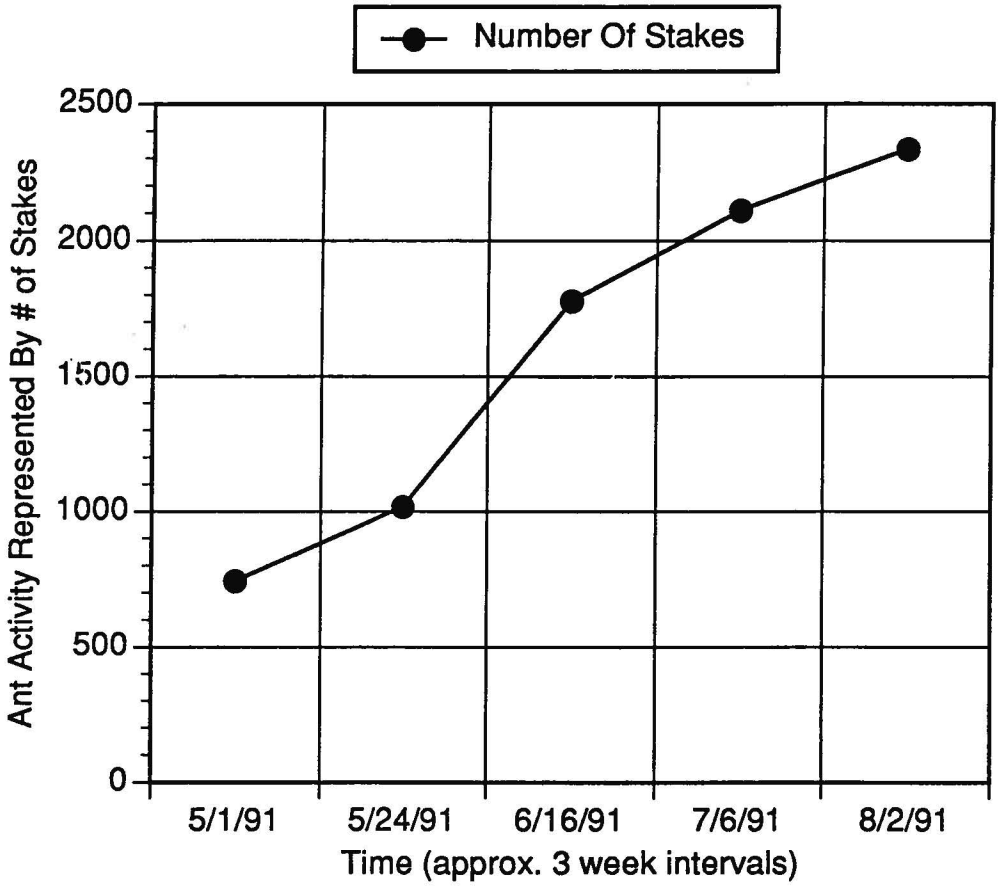
TABLE 4. ANT COLONY LOCATION AND SIZE (#STAKES)

7/6/90

SO.	MERCED 1	NO.	SO.	MERCED 2	NO.	SO.	MERCED 3	NO.	SO.	MERCED 4	NO.
	1			1	6		1			1	
	2			2	7		2	16		2	
	3	8		3	12	10	3	6	20	3	
	4		11	4	14		4			4	12
10	5	4		5	6		5	35	15	5	
	6			6	11		6			6	3
10	7	3	11	7	8		7	30		7	
	8	15	5	8	15	8	8			8	23
	9			9	9		9	20		9	13
12	10	8	5	10	3		10			10	20
	11	18		11	21		11			11	20
	12	19	2	12		11	12			12	15
7	13	8	12	13	18		13	25	7	13	9
	14	11		14			14			14	
19	15	16	21	15			15	13		15	9
5	16	3		16			16	3		16	8
	17	39	24	17	8		17	17	3	17	12
	18	45	13	18			18			18	18
	19	3		19	13		19	12		19	
17	20	5	10	20			20		3	20	21
9	21	10	1	21			21			21	4
13	22	3	23	22			22			22	
4	23	12	1	23	7		23			23	
4	24			24	16		24	15	6	24	1
14	25	8		25	3		25	29	7	25	12
	26	15	2	26	28		26		8	26	18
	27	14		27	10		27			27	2
	28	5	3	28	16		28		4	28	4
	29		8	29	29	3	29	17		29	24
	30			30			30	6		30	4
	31	3		31		3	31	4		31	6
	32			32	9		32	20		32	20
	33		16	33	6		33	17		33	17
	34			34			34			34	27
	35	27	12	35	3		35			35	
	36	24	6	36	21		36	20	2	36	
	37			37	6	24	37		7	37	3
2	38			38	19		38			38	1
	39			39			39	12		39	
	40			40	32		40			40	8
	41	11	16	41	10		41			41	23
	42			42	14		42			42	
	43	1		43			43			43	
	44			44	25		44			44	
	45			45	6		45	8		45	
	46	2	4	46	10		46			46	20
	47	2		47			47			47	
	48			48			48		26	48	
	49			49	22	13	49			49	
	50			50	24		50	2		50	
	51	5		51		18	51		2	51	
	52			52			52			52	
	53			53	13	13	53			53	
	54			54	4		54		9	54	
	55			55			55		6	55	
	56			56	12		56			56	
	57			57		5	57			57	
126	58	347	206	58	496	108	58	327	125	58	377
										Total All Rows:	2112

TABLE 5. ANT COLONY LOCATION AND SIZE (# STAKES)

					8/2/90						
SO.	MERCED 1	NO.	SO.	MERCED 2	NO.	SO.	MERCED 3	NO.	SO.	MERCED 4	NO.
	1			1	6		1			1	
	2			2	8		2	18		2	
	3	8		3	15	11	3	6	21	3	
	4		12	4	15		4			4	12
10	5	5		5	6	3	5	35	18	5	
	6			6	11		6		2	6	6
11	7	3	11	7	9		7	30		7	
	8	15	7	8	15	8	8			8	23
	9			9	9		9	21		9	13
13	10	8	5	10	5		10			10	21
	11	24		11	21		11			11	20
	12	22	5	12		11	12			12	15
7	13	8	13	13	20	2	13	26	9	13	10
	14	13		14	3		14			14	
21	15	16	25	15			15	14		15	11
5	16	5		16			16	3	1	16	8
	17	39	26	17	8		17	19	4	17	13
	18	45	13	18			18			18	18
	19	3		19	14		19	12		19	
19	20	5	10	20			20		3	20	23
10	21	13	2	21		2	21			21	4
13	22	3	23	22			22			22	2
4	23	13	1	23	7		23			23	
5	24			24	17		24	15	6	24	1
15	25	8		25	4		25	30	12	25	12
	26	17	7	26	32		26		8	26	20
	27	14		27	10		27			27	2
	28	5	4	28	17		28		4	28	5
	29		8	29	29	3	29	18		29	24
2	30		2	30			30	6		30	4
	31	6		31		7	31	5		31	6
	32	2		32	10		32	20		32	21
	33		18	33	8		33	18		33	19
	34			34			34			34	27
	35	29	13	35	3		35			35	
	36	26	6	36	22		36	20	2	36	
	37			37	6	25	37		9	37	3
2	38		10	38	21		38			38	1
	39			39			39	13		39	
	40			40	32		40	2		40	9
	41	15	17	41	13		41			41	23
	42			42	14		42			42	
	43	3		43		5	43			43	
	44			44	26		44			44	
	45			45	6		45	13		45	
	46	3	4	46	11		46		1	46	21
	47	2		47			47			47	
	48			48			48		26	48	
	49			49	22	13	49			49	
	50			50	27		50	2		50	
	51	5		51		19	51		22	51	
	52	1		52			52			52	
	53			53	14	15	53	4		53	
	54			54	4		54		10	54	
	55			55			55		6	55	
	56			56	13		56			56	
	57			57		5	57			57	
137	58	384	242	58	533	129	58	350	164	58	397
									Total All Rows:		2336



Graph 1. Fire ant mound building activity as measured by number of stakes 1 foot apart.