81-A8

PROJECT NO. - 81-A8 - Navel Orangeworm Research Pheromone Field Testing

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I. OBJECTIVES: (1) To develop a control measure for navel orangeworm (NOW) using synthetic sex pheromone for mating disruption; (2) to continue work on development of pheromone materials as attractants for monitoring NOW activity in the field (3) to continue studies using peach twig borer (PTB) sex pheromone for PTB control by mating disruption.

II. INTERPRETIVE SUMMARY: Field testing of the NOW sex pheromone component, (Z,Z)-11,13-hexadecadienal, in 1978-1981 has shown that the existing material is not useful as a trap lure for male moths for monitoring populations and timing insecticide treatments. The material appears to be useful in trapping moths only in extremely high moth populations and not useful during spring and early hull split when moth populations are normally at low levels. Male catches in traps baited with the NOW aldehyde were only 8% of those where 3 virgin females were used as trap bait - the most favorable comparison for any tests run in 1980.

The existing NOW aldehyde has been shown to be a promising material for disrupting male catches in traps and mating of virgin females when applied to 9-tree and 20-acre plots. Nut damage was reduced as much as 61% in one 20-acre plot in 1980 - tests. The NOW aldehyde has good potential as a control agent in any integrated pest management (IPM) strategy. A long lasting (3 weeks) slow-release formulation has been developed through the cooperation of Zoecon in Palo Alto, California, Hercon in New York City and Albany International in Needham Heights, MA, and Columbia, Ohio.

One possible way to control the NOW is by preventing mating and subsequent egg laying. Male moths find females for mating by following a trail of chemical scent (sex pheromone) released by the females. The natural pheromone trails can be camouflaged by permeating the air in an almond orchard with synthetic pheromone. This confuses the males or in some way prevents the males from finding the females for mating. The NOW aldehyde, (Z,Z)-11,13-hexadecadienal can be released over a period of time from emitters hand placed or applied by ground or aerial equipment. About 5 grams (0.01 pound) of actual material per acre disrupted male catches in pheromone traps and mating of virgin females for about 3 weeks in 1979- and 1980-tests. For some reason, treatments had to be made at 10-day intervals in 1981-tests to obtain the degree of disruption achieved with the less frequent treatment schedule used in 1980-tests. The success of mating disruption is heavily dependent on population size, air temperature and other factors. The unusually hot summer and high moth populations may have contributed to some of the problems in the 1981-field plots, but there are still problems with the NOW aldehyde compound and formulation. More work is needed in identifying other components of the sex pheromone to yield a material useful as a trap lure and a more effective mating disruptant.

No material was received from Dr. Tom Baker for field testing. Dr. Jerome (Jerry) Klun, Organic Chemical Synthesis Laboratory, USDA, Beltsville, MD, has been working with us since February, 1981, to find other components of the NOW sex pheromone. He has made considerable progress and has sent some materials to Fresno for field testing. So far the materials are only a minor improvement over the (Z,Z)-11,13-hexadecadienal.

In 1981 - tests, a major effort was made to accomplish a reduction in nut damage by using the NOW aldehyde for mating disruption in Merced county almond orchards. The work plan called for six 20-acre plots to receive 3 hand treatments, one in late June, a second in late July and a third in mid - August. This schedule would have resulted in about 3 weeks between treatments with 5 grams per acre per treatment. Pheromone (3,000 g) was purchased from Albany International. The material was of high isomeric and overall purity (98% overall with 93% Z,Z, 2% Z,E, 3% E,Z and <1% E,E isomeric). Hercon purchased some of the pheromone and formulated all of the material at no cost.

After the first treatment, the trap and mating table results showed that the degree of protection was not adequate when compared to our 1980-findings. We therefore decided to cut back to three 20-acre plots to be treated at 10-day intervals resulting in 6 treatments with 5 grams of material per acre per treatment.

We monitored the effects of the sex pheromone treatments by checking for a reduction or elimination of male catches in sticky traps baited with virgin females, and by checking the mating success of females placed in orchard plots. Also, nut samples were collected for damage estimates.

Trap catches of males in Plots 1-3 were (check:test): 2341:54, 1504:14 and 1535:32. Trap catches were reduced by 97.7%, 99.1% and 97.9%. Mating success of females placed in plots was reduced by 76%, 94% and 81%, respectively, in Plots 1-3 during the early part of the season (July 7 - August 12). Later in the season (August 19 - September 9) mating success was reduced by 50%, 73% and 5%. Nut damage at harvest was reduced by 34%, 12% and 22%, respectively, for Plots 1-3. The 34% figure for Plot No. 1 was the only one statistically significant ($P < 0.05$). It appears that the single component pheromone that we are using and/or the rate being applied is not useful in controlling the navel orangeworm in orchards with high populations. We need the more complete pheromone, better formulations to protect the pheromone from heat and oxidation and perhaps higher rates of application.

We are still optimistic in being able to develop a pheromone control strategy as an alternative to in-season insecticide applications during spring and summer months. This would also reduce the chances of creating mite problems as predators and parasites would not be destroyed. Also, there would be no undesirable residues on almond kernels and hulls. It may take several years to develop the pheromone into a usable control program. We still have problems with formulation and application. A cheaper method of synthesis is needed to make the use of pheromones economically feasible. We are still looking for other components so that a more effective pheromone can be made that might allow the use of smaller amounts of material.

The pheromone system would still represent only one part of a pest management operation. Mating disruption works best against low insect populations. Therefore, the already proven good orchard management practices of orchard sanitation, early and rapid harvest and control of peach twig borer would still form the foundation for any IPM program.

A. Field attractiveness of the synthetic NOW aldehyde and other materials

III. EXPERIMENTAL PROCEDURE: The only tests made in 1981 were with some materials supplied by Dr. Klun, USDA, Beltsville, MD. Materials used were (Z,Z)-11,13-hexadecadienal (aldehyde) (100μg), 80:20 mixture of aldehyde (100μg) and corresponding alcohol (25μg), 95:5 mixture of aldehyde (100μg) and corresponding alcohol (5.2μg), a 78:8:14 mixture of the aldehyde (100μg) and corresponding alcohol (10.4μg) and corresponding acetate (18μg), blanks and unmated females (3/trap-contained in a fiberglass screen enclosure). Phercon(R) 1C traps were used in all tests. Materials to be tested were applied in 20μl heptane to Thomas #8753-D22 rubber stoppers (5 x 9 mm) or cotton dental roll. Traps were spaced 5 trees and 10 rows apart in a mature almond orchard rows run north and south. They were placed 2 m above the ground. Test design was a randomized complete block. Trap catches of navel orangeworm and *Pyralis farinalis* males were recorded.

The first test was set up on April 13, 1800 h, and due to cool temperatures, it was run for 10 nights. Each treatment was replicated 3 times using rubber stoppers as substrates for test materials.

The second test was set up on April 24 and was run for 3 nights. Each treatment was replicated 3 times using rubber stoppers and 3 times using dental rolls.

The third test was set up on April 30, 0100-0135 h, and run for 3 nights. At 0135 h, it was 16°C and females had just begun to call and there were a few males flying around traps baited with unmated females. Each treatment was replicated 3 times using rubber stoppers as substrates for test materials.

IV. RESULTS: Test results (Table 1) showed that dental rolls did not provide as good a substrate for test materials as did rubber stoppers. None of the mixtures of aldehyde, alcohol and acetate were more attractive than the aldehyde alone. None of the materials were more than 2% as effective as 3 unmated females used as bait. Test 3 results showed that *Pyralis* *farinalis* males were caught in about the same numbers in traps baited with test materials as in traps baited with unmated females.

V. DISCUSSION: The NOW aldehyde has been tested as a lure for trapping NOW males for the past four years. The material appears to be useful only in high populations and therefore, not useful for monitoring the spring and early summer moth activity. Many of the tests have shown the aldehyde alone and various mixtures to be as effective as unmated NOW females in attracting *P. farinalis* males to traps.

B. Comparisons of Hercon(R) formulations of the NOW aldehyde

III. EXPERIMENTAL PROCEDURE: The NOW aldehyde used in these tests was purchased from Albany International and was 98% overall purity and 93% (*Z*,*Z*), 2% (*Z*,*E*) 3% (*E*,*Z*) and <1% (*E*,*E*) isomeric purity. This was the same material used in the main disruption trials.

The NOW aldehyde was formulated on July 30, 1981, in 1x1-inch square Hercon(R) laminates and tested in 9-tree plots set up on August 5, 1981. The check plots were always located north of the treated plots which generally kept them upwind of any treatments. Varietal arrangements and interplot distances were standardized within blocks. All treatments were made without replication. Cooperating grower was Doane Wagner. The number of 1x1-inch dispensers per tree was 1 at 2 m, 1 at 5 m and 2 at 7 m above ground.

Treatment Number (Hercon(R) Lot Number)	Color Plastic	Thickness of Center Layer	Active material applied per plot (mg)	Active material applied per acre (g)
1 (L 278-35-2)	Orange	1X	538	6.45
2 (L 278-36-2)	Blue	2X	1075	12.90
3 (L 278-36-1)	Orange	2X	1075	12.90
4 (L 278-35-1)*	Blue	1X	538	6.45

*Standard formulation used in main disruption trials was blue-plastic-outer-layers with standard thickness (1X) middle layer to provide 16.8 mg per 1x1-inch square.

The materials being tested were applied only to the 8 perimeter trees (designated as "X") leaving the center tree (designated by "O") untreated for monitoring.

X X X
X O X
X X X

Trap catches of males and mating success of wing-clipped females in the plots were used to evaluate mating disruption for comparing treatments.

Pherocon(R) 1C sticky traps, each baited with 3 unmated NOW females contained in a 7x5x4-cm fiberglass-screen cage were placed at 6 m above the ground in the center tree of all treatment and check plots. Catches of males were counted and females were replaced 3 times per week. Three wing-clipped females were placed in mating buckets made of 1-pint polyethylene food containers (10x10x7-cm) open at top to afford easy access of feral males to the females. Also, a specially built roost was made by inserting four 8.5 cm x 6 mm diameter dowels through a 2x2x8.5-cm block of wood to serve as resting sites. Mating success was evaluated one night each week by placing one of the mating bucket setups in place of the sticky trap. These mating buckets were put in plots between 1800 and 2000 h and collected between 0600 and 0800 the following morning. The number of mating pairs was counted and all females were held individually to determine number laying viable eggs.

Five dispensers of each of the 4 experimental formulations were aged in the field for each of the following durations in days (0,1,3,7, 10,14,21,28). All of these were sent to Hercon(R) for release rate determinations.

IV. RESULTS: Male catches in female baited traps in 9-tree plots were at least 84% lower in plots treated with orange plastic-double thickness middle layer (T3) and 70% lower in plots treated with orange plastic-single thickness middle layer (T1) than in check plots over 43-day period (Table 2). Formulations using the blue plastic gave rathern sporadic results after 17 days for the double thickness middle (T2) and after 24 days for the single thickness middle (T4). Figure 1 shows a much better separation for the four treatments when averages for approximately 1-week intervals are plotted. Mating success data for females placed in the orchard (Table 3) showed the formulations using orange plastic (T1+3) to be superior to the blue-plastic double thickness (T2) but not to the blue plastic-single thickness (T4) for the first 8 days of the test. After that mating disruption based on mating of wing-clipped females was very poor for all formulations.

V. DISCUSSION: All four of the experimental Hercon(R) formulations gave some degree of disruption of male catch in sticky traps throughout the 43 days (August 5 - September 17) of this test. Overall, the formulations using orange plastic were definitely superior to the ones using blue plastic. Disruption of mating of wing-clipped females placed in the plots was only successful for the first 8 days of the test and showed the blue plastic-single thickness middle layer (formulations used in our 20-acre plot disruption studies) to be the best formulation. All formulations rapidly lost effectiveness after the first 8 days of the test.

It may be useful to further test the formulations using the orange plastic, but much remains to be done to improve the pheromone itself and the formulations.

C. Disruption in 20-acre plots using (Z,Z)-11,13-hexadecadienal formulated in Hercon(R) laminates

III. EXPERIMENTAL PROCEDURE: The pheromone (3000 g) used in all of the disruption tests was purchased from Albany International (=Chemsampco in Columbus, Ohio). Dr. Jim Tumlinson, USDA, Gainesville, Florida, spent much time consulting with Albany so that a commercial synthesis could be developed to produce high quality pheromone. Dr. Tumlinson reported on January 12 that Albany had made 500 g of material that was 87% Z,Z but contained many impurities. On March 13, Dr. Tumlinson reported that he had reviewed a sample from Albany that was 92% (Z,Z)-11,13-hexacadienal with about 2% or less of each of the (Z,E) isomer, (E,Z) isomer and and (E,E) isomer. This agreed closely with the Albany analysis results. We agreed that Albany was capable of producing the NOW aldehyde and of analyzing the product for good quality control. On April 23, Dr. Mike Barry, Hercon, New York City, reported that Dr. Jerry Klun, USDA, Beltsville, MD, had analyzed the Albany material to be used in field tests and determined it to be 98% overall purity and 93% (Z,Z), 3% (E,Z) and <1% (E,E) isomeric purity. The figures were confirmed by Dr. Barry on June 1. Later, Dr. Peter Landolt, USDA, Miami, FL, also confirmed these data.

These large scale (20-acre) disruption plots were set up using the NOW aldehyde formulated in Hercon(R) laminates. Each treatment plot was matched with an equal size check plot upwind (north) of the treated area within the same orchard.

The research plans called for the use of 144,000 square inches of laminate: 6 plots X 20 acres per plot X 75 trees per acre X 4 $in.^2$ of laminate per tree X 4 applications (at 3-week intervals). This would require 36,000 pieces of laminate 1x2 in. and 72,000 pieces 1x1 in. for application of one 1x2 in.-piece and two 1x1 in. -pieces (=4 $in.^2$) per tree per application. The material received was Hercon(R) Luretape(TM) containing 16.8 $mg/in.^2$ (Z,Z)-11,13-hexadecadienal. Each application would be 5 g of active material per acre. The original plan called for 4 treatments with 3 weeks between each treatment. The first treatment was to be about 2 weeks prior to initiation of hull split.

All 6 treated plots and all 6 check plots were monitored for navel orangeworm and peach twig borer activity by using egg traps, sticky traps, light traps and mating buckets. Also, mummy nut counts were made and samples of mummy nuts and new-crop nuts were taken for infestation counts. Trapping was begun on June 5, 1981, for most plots. Mummy nut counts were made on July 22-31. A series of 5-7 samples was taken beginning on July 29 to study infestation in new-crop nuts prior to harvest. Harvest samples were taken on Sept 2, 10, 17 and 19 depending on the commercial harvest date for a given orchard.

Egg Traps: Commercially available Pherocon(R) IV traps were purchased from Zoecon(R) Corporation, Palo Alto, CA. These are the standard oviposition traps used to monitor NOW egg laying in the field. The traps were baited with almond-press-cake meal purchased from Liberty Vegetable Oil Co., Norwalk, CA, and ground in a laboratory meat grinder. Each trap received 7 drams of bait which brought the surface of the bait about one quarter of the way up in the side openings of the trap. Eggs were counted and removed from traps 3 times each week. The bait and traps were changed at weekly intervals, and the traps were held for determination of the count of non-viable eggs. One trap was placed within the tree canopy at 6-7 m above the ground depending on height of tree in each of 4 trees per plot (Figure 2).

Sticky Traps: Commercially available Pherocon(R) 1C sticky traps were purchased from Zoecon(R) Corporation. Each was baited with 3 unmated female NOW moths contained in a 7x5x4 - cm fiberglass-screen cage. Male catches were counted 3 times each week. Sticky traps were located in the same 4 trees used for egg traps at 6-7 m above the ground (Figure 2).

Light Traps: These were built at our laboratory by using 4 D-cell batteries to power a voltage multiplying circuit to dimly light a 5 watt blacklight fluorescent tube (F 8T5/BL). Moths attracted to the light fell into a funnel and then into a plastic bag containing a small piece of Vapona strip. Trap catches were collected at weekly intervals, and the numbers of male and female NOW and peach twig borer moths were counted. Female NOW were dissected to determine whether or not they had been mated. Two traps per plot at 6-7 m above the ground (Figure 2).

Mating Buckets: Mating success of laboratory reared wing-clipped females placed in the plots one night per week was another way to evaluate mating disruption effectiveness. This was begun on July 7 and was done in the same 4 trees used for egg traps and sticky traps plus 6 other trees within the plot (Figure 2). The sticky traps were not baited on this one night per week. Three wing-clipped females were placed in 1-pint polyethylene food containers (10x10x7-cm) open at top to afford easy access of feral males to the females. Also, a specially built roost was made by inserting four 8.5 cm x 6 mm diameter dowels through a 2x2x8.5-cm block of wood to serve as resting sites. Petroleum jelly around the lip of the containers kept the females from escaping. These set-ups were placed in each monitor tree at 6-7 m above the ground late in the afternoon (1800-2000 h) and collected soon after sunrise the next morning (0600--0800 h). The number of mating pairs was recorded at collection time and the females were held individually to determine number laying viable eggs.

Mummy-Nut Samples: These were collected one time only from each of the six treated and six check plots. The number of mummy nuts was counted on the 8 trees bordering on each of the 10 trees containing mating tables being careful to insure that all varieties within the plot were represented. We tried to obtain a 100-nut sample from each variety except for Mission to determine numbers of damaged nuts and numbers of larvae and pupae. We then calculated the numbers of damaged nuts and of larvae and pupae per acre. Plots 1 and 6 were sampled on July 29, Plot 2 on July 23, Plot 3 and 4 on July 22, and Plot 5 on July 31.

<u>New-Crop-Nut Samples</u>: These were collected at weekly intervals beginning shortly after first hull-split taking 100 nuts from Nonpareil trees about 2 trees away from each of the 10 mating-bucket monitor trees in each plot. Sample dates and direction of sample site from monitor trees were July 29 - north, August 6 - south, August 13 - east, August 19 - west, August 27 - northeast, Sept. 2 - southwest and Sept. 10 - southeast. Only Plots 1-3 were sampled on these dates. Plot 3 was not sampled on August 6 because of irrigation and on Sept. 2 and Sept. 10 as the orchard had been harvested. Plot 1 was not sampled on Sept. 10 as the orchard had been harvested.

At harvest, 30 samples of 100 Nonpareil nuts each were taken from the ground from 6 sites in each of 5 tree rows evenly distributed within each plot. These samples were evaluated for NOW, peach twig borer and other insect damage and nunbers of eggs, larvae and pupae. On Sept. 2, harvest samples were taken from Plots 3 and 5. Plot 3 samples were from rows 6, 11, 16, 21, 26 numbered from north to south and trees 5, 13, 21, 29, 37, 45 numbered from west to east. Plot 5 samples were from rows 6, 11, 16, 21, 26 numbered from north to south and trees 8, 17, 26, 35, 44, 53 numbered from west to east. On Sept. 10, Plots 1 and 6 were sampled. Sample sites for Plot 1 were numbered the same as for Plot 3. Plot 6 sites were numbered the same as for Plot 5. On Sept. 17, Plot 4 was sampled and Plot 2 was sampled on Sept. 19. Sample sites for these 2 plots were numbered the same as for Plot 3.

<u>Release Rate Tests</u>: The laminates were aged in the field for various periods of time, held in a freezer until the end of the season and then sent to Hercon(R) for release rate determinations. Five dispensers were aged for each of 10 time periods (0, 1, 3, 7, 10, 14, 21, 28, 35 and 42 days) for each of 3 of the applications - Applications 1, 2 and 4. Application 4 had one series of samples from full sun location and a second series of samples from full shade location.

<u>Plot Descriptions</u>:

<u>Plot No. 1a</u>: <u>(=Uhrhammer North - Check)</u>

31 rows x 49 trees = 1519 trees = 20.25 acres

Rows run east and west - 75 trees acre - square pattern

11.11 acres	Nonpareil
5.00 acres	Neplus
3.27 acres	Merced
0.87 acres	Mission

Almonds on all borders of plot

Insecticide treatment = Imidan - dormant

Plot No. 1b: (=Uhrhammer North - Treated)

Same as for check except

10.90 acres Nonpareil

3.91 acres Neplus

1.96 acres Merced

3.48 acres Mission

Plot No. 2a: (=Uhrhammer South - Check)

31 rows x 49 trees = 1519 trees = 20.25 acres

Rows run east and west - 75 trees per acre - square pattern

17.86 acres Nonpareil

2.39 acres Merced

Almonds on all 4 borders of plot

Insecticide treatment = Imidan - dormant

Plot No. 2b: (=Uhrhammer South - Treated)

Same as for check except pasture and dairy on south border plot.

Plot No. 3a: (=Aldrin West - Check)

31 rows x 49 trees = 1519 trees = 20.25 acres

Rows run north and south - 75 trees per acre - square pattern

13.63 acres Nonpareil

3.31 acres Neplus

3.31 acres Merced

Almonds on north, east and south borders

Grapes near north border

Open pasture on west border

Insecticide treatment = Parathion - May

Imidan - July 10

Plot No. 3b: (=Aldrin West - Treated)

Same as for check except no grapes near north border

Plot No. 4a: (=Aldrin East - Check)

31 rows x 49 trees = 1519 trees - 20.25 acres

Rows run north and south - 75 trees per acre - square pattern

13.63 acres Nonpareil

3.31 acres Neplus

3.31 acres Merced

Almonds on all 4 borders of plot

Insecticide treatment = Parathion - May

Imidan - July 10

Plot No. 4b: (=Aldrin East - Treated)

Same as for check

Plot No. 5a: (=Wagner West - Check)

32 rows x 59 trees = 1888 trees = 17.48 acres

Rows run east and west - 108 trees per acre - diamond pattern

8.75 acres Nonpareil

2.18 acres Kapareil

2.18 acres Merced

4.37 acres Mission

Almonds on all borders except open pasture on north border

Insecticide treatment = Parathion - dormant

Guthion - May

Plot No. 5b: (=Wagner West - Treated)

34 rows x 59 trees = 2006 trees = 18.57 acres

Rows run east and west - 108 trees per acre

9.29 acres Nonpareil

2.18 acres Kapareil

2.73 acres Merced

4.37 acres Mission

Almonds on all 4 borders of plot

Plot No. 6a: (=Wagner East - Check)

Same as for Plot No. 5a

Plot No. 6: (=Wagner East - Treated)

Same as for Plot No. 5b

Application of NOW aldehyde: Plots 1-4 which were 31 x 49 = 1519 trees were treated with 1 in.^{2} of Hercon(R) laminate at 7 feet, 1 in.^{2} at mid-canopy, and 2 in.^{2} high in canopy to give 4 in.^{2} per tree. No pheromone was placed in the 10 trees containing sticky traps, egg traps and/or mating buckets. This resulted in 5.01 g of NOW aldehyde per acre.

Plots 5-6 which were 34 x 59 = 2006 trees were treated with 1 in.^{2} of laminate at 6 feet skipping every fifth tree, 1 in.^{2} at mid-canopy, and 1 in.^{2} high in canopy to give 3 in.^{2} in 4/5 of trees and 2 in.^{2} in 1/5 of trees. No pheromone was placed in the 10 trap trees. This resulted in 5.08 g of NOW aldehyde per acre.

The laminate piece placed in the low position was stapled to the NE side of the tree to afford maximum protection from the sun. The mid- and high canopy laminate pieces were stapled to specially constructed metal clips that were then snapped onto a small branch using a specially constructed applicator mounted on a 16- or 20-foot pole. The clips were to be placed in a shaded position within the tree canopy, but the high-position clip often was placed such that the laminate piece received direct sun for several hours each day.

Application of the pheromone dispensers required 3.2 man-hours per acre for the first application, 2.8 for the second, 2.5 for the third, 1.9 for the fourth, and 1.8 for the fifth and sixth application.

Application dates and (number of days since previous application)

Plot No. 1 (6 applications) - June 30, July 20 (20 days), July 30 (10 days), Aug. 10 (11 days), Aug. 21 (11 days), Sept. 1 (11 days).

Plot No. 2 (6 applications) - June 29, July 20 (21 days), July 30 (10 days), Aug. 10 (11 days, Aug. 20 (10 days), Sept. 1 (12 days).

Plot No. 3 (5 applications) - July 1, July 21 (20 days), July 31 (10 days), Aug. 11 (11 days), Aug. 20 (9 days).

Plot No. 4 - June 30 only

Plot No. 5 - July 2 only

Plot No. 6 - July 2 only

IV. RESULTS: Egg counts on almond-presscake-meal baited egg traps were 2%, 58% and 48% lower in treated blocks than in check blocks in Plots 1-3, respectively (Table 4). Pretreatment counts were low in all of the plots but did indicate somewhat higher moth activity in the treated areas than in the check areas for Plots 1 and 2 and the reverse of this for Plot 3. Figure 3 shows the differences in egg counts for treated and check areas in Plots 1-3 plotted as total eggs per trap per week. Figure 4 shows the same information as cumulative egg deposition per trap per week. Also shown are the treatment dates (T1-6) and the harvest dates.

Catches of males in sticky traps baited with virgin females were 97.7%, 99.1% and 97.9% lower in treated areas than in check areas for Plots 1-3, respectively (Table 5). Trap catch reductions were 98.7%, 99.8% and 99.4% early in the season (July 1 - August 14), and they were 96.3%, 98.6% and 95.6% later in the season (August 15 - harvest) showing some decrease in effectiveness of the treatment when populations were higher. Figures 5-7 show the differences in trap catches of males in treated and check blocks in Plots 1-3 plotted as total catch per trap per week. Figures 8-10 show the same information as cumulative catch per trap per week. All of these figures have the treatment dates (T1-6) and the harvest dates and NOW damage at harvest marked on them.

Catches of NOW moths in black light traps were 49%, 48% and 33% lower in tested areas than in check areas in Plots 1-3, respectively (Table 6). Pretreatment catches were low in all of the plots but were consistently somewhat lower in the treated areas than in the check areas for all three plots. Figures 11-13 show the differences in moth counts for treated and check areas in Plots 1-3 plotted as total moths per two traps per week. Figures 14-16 show the same information as cumulative moth counts per two traps per week. Also, the treatment dates (T1-6) and harvest dates are shown.

Mating success of wing-clipped females placed in the plots was 65%, 85% and 65% lower in treated areas than in check areas for Plots 1-3, respectively, for the entire season from July 7 to harvest (Table 7). Mating success was reduced by 76%, 94% and 81% early in the season (July 7 - August 12) (Table 7), and it was reduced by 50%, 73% and 5% later in the season (August 19 - harvest) showing a pronounced decrease in effectiveness of the treatment when moth populations were high. Figures 17-19 show the reductions in male catches in sticky traps and in mating success throughout the season. Note how much more sensitive the mating success evaluation is compared to the male catch evaluation method. One can see the decline in effectiveness of the pheromone to prevent mating between each treatment.

Mummy nut counts made between July 22 and July 31, numbers of NOW-damaged kernels per acre and numbers of NOW larvae plus pupae per acre are shown in Table 8 for Plots 1-6. The numbers of larvae plus pupae per acre in Plots 1 and 2 indicate low population pressures under which mating disruption should be a useful tool. Counts in Plot 3 shows a poor match of check and treated area. Even though the blocks were close together, one can see there were about 3.5 x nuts and 6.7 x larvae plus pupae per acre in the check than in the treated area. Plot 4 had a good match of counts for the check and treated areas, but too high a population for pheromone disruption of mating. Plots 5 and 6 contained many more nuts and larvae and pupae in the treated than in the check areas indicating one possible reason for the pheromone not appearing to perform well after the first application.

Nut damage at harvest in Plots 1-3 (check:test): 7.5%:5.0%, 9.3%: 8:2% and 8.9%:7.0% (Table 9). This represented reductions in nut damage of 34%, 12% and 22%, respectively. The 34% figure for Plot No. 1 was statistically significant ($P < 0.05$). The average reduction for those nut samples taken between hull split and harvest was 28%, 3% and 20%, respectively, for Plots 1-3.

Nut damage at harvest in Plots 4-6 which received only the one treatment of pheromone was (check:test): 15.3%:17.2%, 2.4%:6.1% and 3.9%:5.1%.

All of these comparisons showed more damage in the treated blocks than in the check blocks; 13%, 156% and 29%, respectively.

The counts for viable and nonviable eggs and for egg chorions on nut samples taken at weekly intervals from July 29 through September 10 are shown in Table 10. The counts for larvae plus pupae for these samples are shown in Table 11. About 3 x to 4 x more nonviable eggs were laid in treated than in check areas. The nonviable egg count was generally only a small fraction of the viable egg count except for the treated area in Plot 2 in which 26% of the total egg count was non-viable eggs compared to 8% in the check area in this same Plot. The total number of larvae and pupae counted on the seven sampling dates was 23% less, 11% greater and 30% less for the treated area than for the check area in Plots 1-3, respectively (Table 11). The values for Plots 1 and 3 are in general agreement with the values for reductions in nut damage.

V. DISCUSSION: Only Plots 1, 2 and 3 were maintained for a long enough period of time to supply any meaningful data on mating disruption. We had to change our work plan from four applications made at three week intervals to six applications made at 10 day intervals. Therefore, Plots 4, 5 and 6 had to be deleted from our schedule after the first application to have enough pheromone to manage the increased number of applications to Plots 1, 2 and 3.

Many of the problems that we had during the 1980-season were not operating during the 1981-season. Whereas we had a difficult time having enough pheromone when we needed it for application in 1980, we had the entire amount of pheromone needed for the season formulated and in our hands at the beginning of the season in 1981. The material for this season's work was of high purity and had been evaluated by several qualified people, unlike some of the material used in 1980.

In some cases, much of the difference in nut damage in comparisons of check blocks and treated blocks can be explained by factors other than the pheromone treatment. For Plot 1, there was really little difference in total insect damage (NOW + PTB + OFM) for any of the 7 sample dates from July 29 to August 10. Most of the additional NOW damage probably was on nuts already damaged by PTB or OFM. Total insect damage was 7.5% in the check and 6.2% in the treated areas on August 6 and was about the same 5 weeks later at harvest on September 10; i.e., 8.0% in the check and 5.5% in the treated areas. Mummy nut data (Table 8) did show 10 larvae plus pupae per acre in the check compared to 40 in the treated area. This does indicate that the pheromone treatment kept the 4x larger population from inflicting greater damage in the treated area than in the check area.

Plot 2 had a very low amount of PTB and OFM damage (Table 9) and a very low mummy nut level (Table 8). The few mummies found were either shrivels or had the kernels eaten out by birds. We found no live NOW larvae or pupae in the mummy nut samples. This coupled with the best reduction in male catch in sticky traps and in mating success of females placed in the orchard (compare Figures 17, 18 and 19) for Plots 1, 2 and 3 should have made this the best Plot for demonstrating a reduction in nut damage due to the pheromone treatment. However, the 12%

reduction in nut damage was the poorest comparison for any of these plots. The nut damage remained at a low level, about 3% for NOW + PTB + OFM, for the first six weeks of sampling. It then increased rapidly in the check and treated areas over the last two and one-half weeks leading up to harvest to give 9.4% in the check compared to 8.3% in the treated. Plot 2 had a very low production per acre, about 500 pounds per acre, compared to 1500-2000 pounds per acre for the other plots. This probably accounts for the rapid increase in damage and large percent reject figures, but it should not have influenced our ability to show a large benefit due to the pheromone treatment.

Plot 3 had a very low amount of PTB and OFM damage (Table 9). The check area had about 6.7 x more larvae and pupae in the mummy nuts than did the treated area - 420 per acre compared to 63 per acre (Table 8). This really put the check area at a disadvantage and probably accounts for the reject level being low in the treated than in the check area. Both NOW reject levels, 8.9% in the check and 7.0% in the treated are high because of the high mummy load in the orchard. The harvest date of September 2 was relatively early for that area of the state, but the large resident population of NOW in the mummy nuts yielded high reject levels even in the first samples taken on July 29.

Table 1.--Comparisons of NOW/*Pyralis farinalis* male catches in traps baited with Mixtures of the Aldehyde, Alcohol and Acetate Applied to Rubber Stoppers and Dental Rolls, or Untreated Rubber Stoppers and Dental Rolls, or 3 Unmated NOW Females. Fresno, CA. 1981.

			No. Male NOW, *Pyralis farinalis* Trapped					
			Ratio of aldehyde:alcohol:acetate*					
Test Number	Duration of Test (nights)	Substrate	100:0:0	80:20:0	95:5:0	78:8:14	Blanks	Females
(1)	10	rubber stoppers	2,1	2,0	4,1	3,2	0,0	241,2
(2)	3	rubber stoppers	2,1	0,0	1,4	2,0	0,0	153,3
		dental rolls	0,0	0,1	0,0	0,0	0,0	255,9
(3)	3	rubber stoppers	0,12	0,19	2,13	0,2	0,0	153,10

*Ratio 100:0:0 = 100μg aldehyde in 20μℓ heptane

Ratio 80:20:0 - 100μg aldehyde plus 25μg alcohol in 20μℓ heptane

Ratio 95:5:0 = 100μg aldehyde plus 5.2 μg alcohol in 20μℓ heptane

Ratio 78:8:14 = 100μg aldehyde plus 10.4μg alcohol plus 18μg acetate in 20μℓ heptane

Table 2.--Comparisons of NOW Male Catches in Sticky Traps Baited with Unmated Females after Treatment of 9-Tree Plots with NOW Aldehyde Formulated in Experimental* Hercon® Laminates. Ballico, CA. August 5, 1981.

Date Trap read (no. nights)	Male Catch/Trap** Check	T1	T2	T3	T4	Cumulative Male Catch/Trap Check	T1	T2	T3	T4	% Disruption T1	T2	T3	T4
8/9 (3)	28	0	2	0	0	28	0	2	0	0	100	93	100	100
8/10 (1)	36	0	3	0	0	64	0	5	0	0	100	92	100	100
8/15 (2)	57	0	5	0	6	121	0	10	0	6	100	91	100	89
8/19 (2)	50	2	11	1	8	171	2	21	1	14	96	78	98	84
8/22 (2)	63	0	10	0	1	234	2	31	1	15	100	84	100	98
8/24 (2)	66	1	49	2	19	300	3	80	3	34	98	26	97	71
8/29 (2)	63	0	8	4	3	363	3	88	7	37	100	87	94	95
8/31 (2)	48	2	49	3	24	411	5	137	10	61	96	0	94	50
9/2 (2)	74	2	18	0	17	485	7	155	10	78	97	76	100	77
9/5 (2)	59	7	43	3	7	544	14	198	13	85	88	27	95	88
9/9 (4)	66	20	56	7	30	610	34	254	20	115	70	15	89	54
9/12 (2)	78	6	21	2	35	688	40	275	22	150	92	73	97	55
9/17 (5)	83	19	86	13	50	771	59	361	35	200	77	0	84	40

**Only one trap each for T1-4. Average for 4 traps for check.

* T1 = L278-35-2 Orange plastic single thickness middle layer

T2 = L278-36-2 Blue plastic double thickness middle layer

T3 = L278-36-1 Orange plastic double thickness middle layer

T4 = L278-35-1 Blue plastic single thickness middle layer = standard

Table 3.-- Percent Reduction in Mating Success of Females Placed Overnight in Plots after Treatment of 9-Tree Plots with NOW Aldehyde Formulated in Experimental* Hercon® Laminates. Ballico, CA. August 5, 1981.

Dates	No. nights after Treatment	No. Mated/Total No. Females Recovered (= Fraction Mated) and (% Reductions over Check)				
		Check	Treated #1	Treated #2	Treated #3	Treated #4
8/5	1	7/7	0/3 (100)	0/3 (100)	0/3 (100)	0/3 (100)
8/10	6	10/12	0/3 (100)	2/3 (20)	1/3 (60)	0/3 (100)
8/12	8	8/12	3/3 (0)	2/3 (0)	1/3 (50)	0/3 (100)
8/16	12	5/12	1/3 (19)	2/3 (0)	0/2 (100)	1/3 (19)
8/19	15	9/12	2/3 (11)	1/3 (56)	2/3 (11)	2/3 (11)
8/26	22	12/12	2/3 (33)	3/3 (0)	3/3 (0)	2/3 (33)
Totals						
8/5, 10, 12	—	25/31	3/9 (58)	4/9 (45)	2/9 (72)	0/3 (100)
8/16, 19, 26	—	26/36	5/9 (24)	6/9 (8)	5/8 (14)	5/9 (24)

*T1 = L278-35-2 Orange plastic - single thickness middle layer
T2 = L278-36-2 Blue plastic - double thickness middle layer
T3 = L278-36-1 Orange plastic - double thickness middle layer
T4 = L278-35-1 Blue plastic - single thickness middle layer = standard

Table 4.--Total Number of Now Eggs Laid on Almond-Meal-Baited Egg Traps Pre-treatment (P) and between First Treatment and Harvest (T) for 20-Acre Plots Treated with NOW Aldehyde Formulated in Hercon® Laminates. Plots were treated on or about June 30, July 20, 30, August 10, 20, and September 1 with about 5g Aldehyde Per Acre Per Treatment Date. No September 1 Treatment for Plot No. 3. Ballico, CA. 1981.

Plot Number (Pretreatment = P or after Treatment = T)	No. of Nights	No. Eggs Laid Per trap (Avg. of 4 Traps Per Plot) Check	Treated	% Reduction in Eggs Laid
1 P	25	4.2	6.4	-
T	72	55.7	54.8	2
2 P	24	0	3.8	-
T	82	74.5	31.4	58
3 P	26	5.5	0.8	-
T	63	62.0	32.0	48

Table 5.--Total Number of Male NOW Caught in Female-Baited Sticky Traps Pretreatment (P) and between First Treatment and Harvest (T) for 20-Acre Plots Treated with NOW Aldehyde Formulated in Hercon® Laminates. Plots were Treated on or about June 30, July 20, 30, August 10, 20, and September 1 with about 5g Aldehyde Per Acre Per Treatment Date. No September 1 Treatment for Plot No. 3. Ballico, CA. 1981.

Plot Number (Pretreatment = P or after Treatment = T)	No. of Nights	No. Males Caught Per Trap (Avg. of 4 Traps Per Plot)		% Reduction in Trap Catch
		Check	Treated	
1 P	25	65	106	-
T	72	2341	54	97.7
2 P	24	33	33	-
T	82	1504	14	99.1
3 P	26	161	137	-
T	63	1535	32	97.9

Table 6.--Total Number of Male Plus Female NOW Moths Caught in Black-Light Traps Pretreatment (P) and between First Treatment and Harvest (T) for 20-Acre Plots Treated with NOW Aldehyde Formulated in Hercon® Laminates. Plots were Treated on or about June 30, July 20, 30, August 10, 20, and September 1 with about 5g Aldehyde Per Acre Per Treatment Date. No September 1 Treatment for Plot No. 3. Ballico, CA. 1981.

Plot Number (Pretreatment = P or after Treatment = T)	No. of Nights	No. Moths Caught Per Trap (Total for 2 Traps Per Plot) Check	Treated	% Reduction in Trap Catch
1 P	25	7	4	-
T	72	1715	868	49
2 P	24	7	1	-
T	82	2452	1277	48
3 P	26	53	34	-
T	63	2261	1512	33

Table 7.--Percent Reduction in Mating Success of Females Placed Overnight in 20-Acre Plots Treated with NOW Aldehyde Formulated in Hercon® Laminates. Plots were treated on or about June 30, July 20, 30, August 20, 30, and September 1 with about 5g Aldehyde Per Acre Per Treatment Date. No September 1 Treatment for Plot No. 3. Ballico, CA. 1981.

Plot Number	Dates	No. of Weeks	No. Mated/Total No. Females (= Fraction Mated)		% Reduction in Mating Success
			Check	Treated	
1	7/7 - 8/12	6	110/177	27/178	76
	7/7 - 9/9	10	185/294	65/297	65
2	7/7 - 8/12	6	106/173	6/177	94
	7/7 - 9/9	10	189/293	28/296	85
3	7/8 - 8/12	6	115/173	22/178	81
	7/8 - 8/26	8	144/224	54/237	65

Table 8.--Total number mummy nuts, NOW infested mummy kernels, NOW larvae and pupae in mummy nuts per acre for six 20-acre plots treated with NOW aldehyde formulated in Hercon® laminates. Counts were made between July 22 and July 31. Ballico, CA 1981.

Almond Variety	Plot No. 1 Check	Plot No. 1 Treated	Plot No. 2 Check	Plot No. 2 Treated	Plot No. 3 Check	Plot No. 3 Treated	Plot No. 4 Check	Plot No. 4 Treated	Plot No. 5 Check	Plot No. 5 Treated	Plot No. 6 Check	Plot No. 6 Treated
					Mummy nut counts per acre							
Nonpareil	180	133	22	8	382	91	432	455	19	146	170	335
Neplus	86	71	--	--	241	64	112	121	--	--	--	--
Merced	43	28	1	1	290	107	688	669	6	49	7	63
Kapareil	--	--	--	--	--	--	--	--	4	109	100	150
Mission	95	656	--	--	--	--	--	--	1	171	323	600
Total	404*	888*	23*	9*	913	262	1232	1245	30*	475	600	1148
					Number NOW-damaged kernels per acre							
Nonpareil	12	20	0	0	169	43	228	150	8	61	5	84
Neplus	1	7	--	--	55	12	29	36	--	--	--	--
Merced	2	8	0	0	102	33	163	213	0	4	1	5
Kapareil	--	--	--	--	--	--	--	--	2	47	41	90
Mission	0	0	--	--	--	--	--	--	0	0	0	0
Total	15	35	0	0	326	88	420	399	10	112	47	179
					Number NOW larvae and pupae per acre							
Larvae 1-2**	3	21	0	0	206	31	187	188	6	67	34	108
Larvae 3-4	4	14	0	0	74	10	94	79	3	33	21	70
Larvae 5-6	3	2	0	0	53	5	48	104	2	23	3	27
Pupae	0	3	0	0	87	7	41	24	2	22	3	18
Total	10	40	0	0	420	63	370	395	13	145	61	223

*Over half of mummies were sticktights or kernel eaten by birds.
**Larvae 1-2 = first and second instars, etc.

Table 9.--Percent Nonpariel Kernel Damage Due to NOW, PTB and OFM Measured Weekly by 10 Samples of 100 Nuts each Taken from each Plot except that 30 Samples of 100 Nuts each were taken at Harvest (Represented by Last Figure in each Column). Three 20-Acre Plots were Treated with about 5g of NOW Aldehyde (Formulated in Hercon® Laminate) Per Acre Per Treatment Date. Plots were treated on or about June 30, July 20, 30, August 20, 30 and September 1. No September 1 Treatment for Plot No. 3. Ballico, CA. 1981.

Navel Orangeworm (NOW)

	Plot No. 1		Plot No. 2		Plot No. 3	
Dates	Check	Treated	Check	Treated	Check	Treated
7/29	3.1	1.1	1.1	0.7	6.3	3.8
8/6	3.8	3.2	1.0	0.7	-	-
8/13	6.5	3.2	1.0	1.0	8.9	5.1
8/19	4.7	3.9	2.1	1.4	7.7	7.9
8/27	5.9	4.2	3.1	3.1	7.4	7.4
9/2	4.4	4.7	1.8	3.0	8.9	7.0
9/10	7.5	5.0	6.2	5.9	-	-
9/17	-	-	-	-	-	-
9/19	-	-	9.3	8.2	-	-

Peach Twig Borer (PTB) + Oriental Fruit Moth (OFM)

	Plot No. 1		Plot No. 2		Plot No. 3	
Dates	Check	Treated	Check	Treated	Check	Treated
7/29	3.8	3.2	2.0	2.2	0.3	1.3
8/6	3.7	3.0	1.1	1.6	-	-
8/13	2.2	2.5	1.5	2.0	0.8	0.3
8/19	1.5	1.5	0.4	1.5	0.9	0.2
8/27	0	1.3	0.7	0.8	0.9	1.3
9/2	1.7	1.3	0.5	0.6	0.3	0.2
9/10	0.5	0.5	0.2	0.2	-	-
9/17	-	-	-	-	-	-
9/19	-	-	<0.1	0.1	-	-

Table 10.--Total number of NOW eggs and chorions on almonds measured weekly by 10 samples of 100 nuts each taken from each plot. Three 20-acre plots treated with about 5g of NOW aldehyde (formulated in Hercon(R) laminates) per acre per treatment date (on or about June 30, July 20, 30, Aug. 20, 30, and Sept. 1). No Sept. 1 treatment for Plot No. 3. Ballico, CA. 1981.

	Plot No. 1		Plot No. 2		Plot No. 3	
Dates	Check	Treated	Check	Treated	Check	Treated
			Total number viable, non-viable eggs			
7/29	0,0	0,0	1,0	1,0	10,0	3,1
8/6	5,0	2,0	3,0	0,0	-	-
8/13	1,0	3,1	5,0	5,1	40,8	41,2
8/19	24,2	31,1	17,2	19,0	29,1	66,5
8/27	36,0	49,5	33,9	44,26	109,0	53,19
9/2	26,0	34,0	24,0	31,16	-	-
9/10	-	-	41,0	23,0	-	-
Totals	92,2	118,7	124,11	123,43	188,9	163,27
			Total number chorions			
7/29	6	0	4	2	34	28
8/6	9	6	2	3	--	--
8/13	8	0	3	0	3	11
8/19	1	11	0	4	0	53
8/27	24	64	35	52	114	73
9/2	29	82	78	37	--	--
9/10	--	--	194	89	--	--
Totals	77	163	316	187	151	165

Table 11.--Total number of larvae plus pupae in NOW damaged kernels and hulls measured weekly by 10 samples of 100 nuts each taken from each plot. Three 20-acre plots treated with about 5g of NOW aldehyde (formulated in Hercon(R) laminates) per acre per treatment date (on or about June 30, July 20, 30, Aug. 20, 30 and Sept. 1). No Sept. 1 treatment for Plot No. 3. Ballico, CA 1981.

	Total no. NOW Larvae plus Pupae					
	Plot No. 1		Plot No. 2		Plot No. 3	
Dates	Check	Treated	Check	Treated	Check	Treated
7/29	26	9	17	13	141	62
8/6	40	69	17	8	-	-
8/13	113	39	13	8	176	87
8/19	69	59	17	15	103	124
8/27	94	63	24	61	147	122
9/2	50	63	20	38	-	-
9/10	-	-	127	117	-	-
Totals	392	302	235	260	567	395
	(-22.9%)		(+10.6%)		(-30.3%)	

Figure 1. Percent reductions in male catches in female-baited sticky traps with NOW aldehyde made by Albany and formulated in Hercon® laminates. Ballico, CA. Treatment made on August 5, 1981.

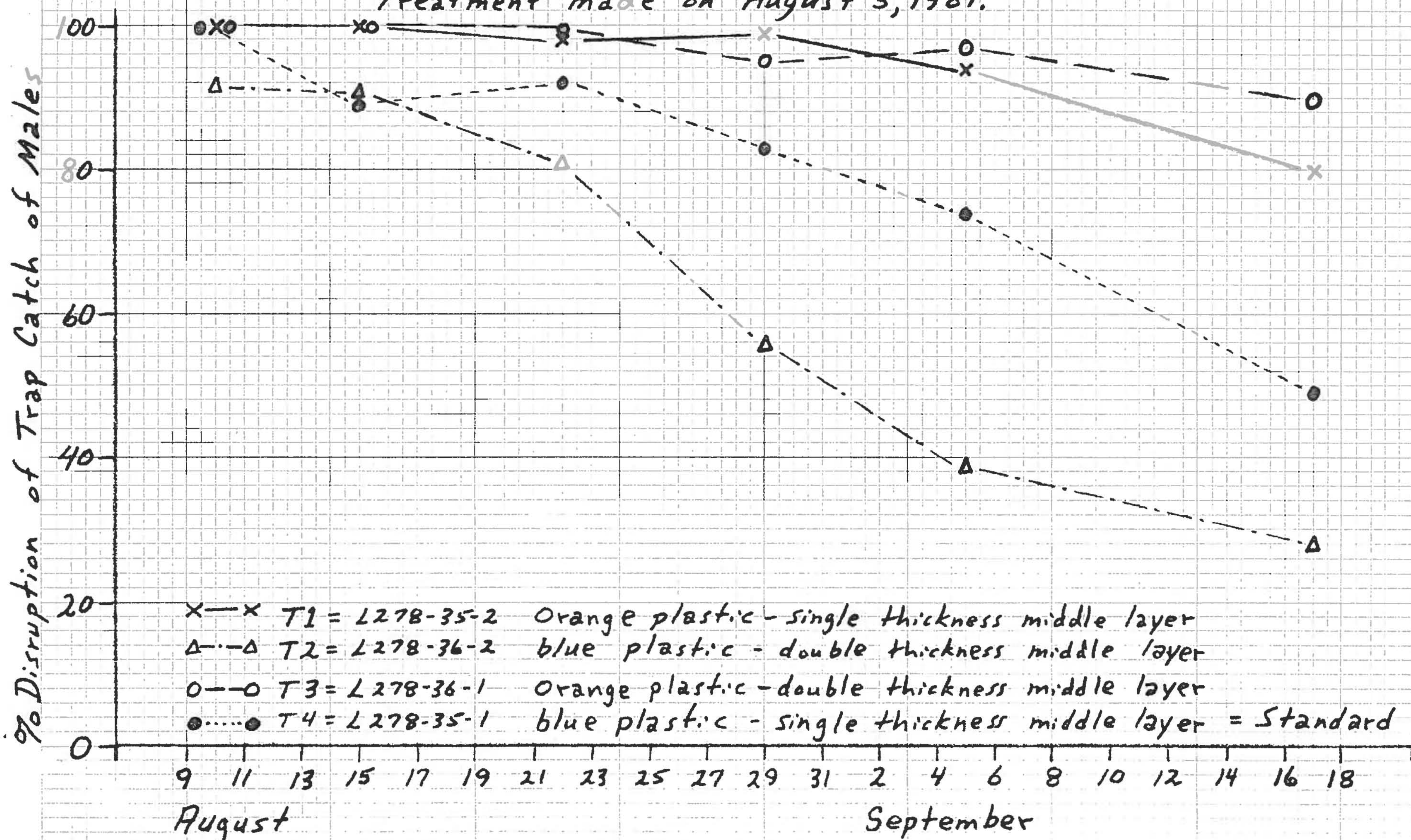


Figure 2. Location of traps within plots which were generally 31 rows X 49 trees = 1519 trees = 20.25 acres. Each plot contained 2 light traps (LT), 4 sticky traps (ST), 4 egg traps (ET) and 10 mating buckets (MB). Ballico, CA. 1981.

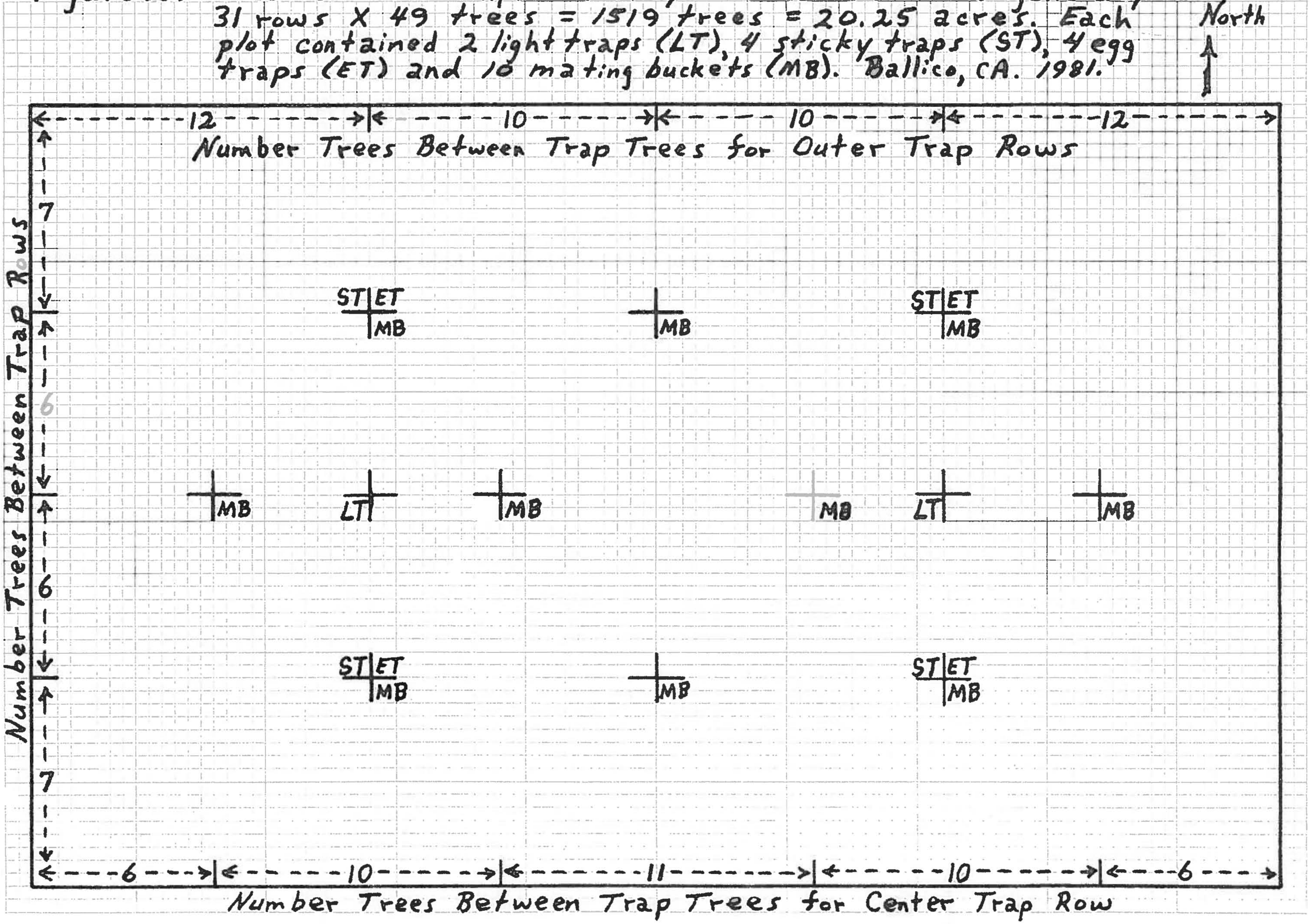


Figure 3. Total NOW eggs laid on almond-meal-baited egg traps per week per trap in 20-acre plots treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

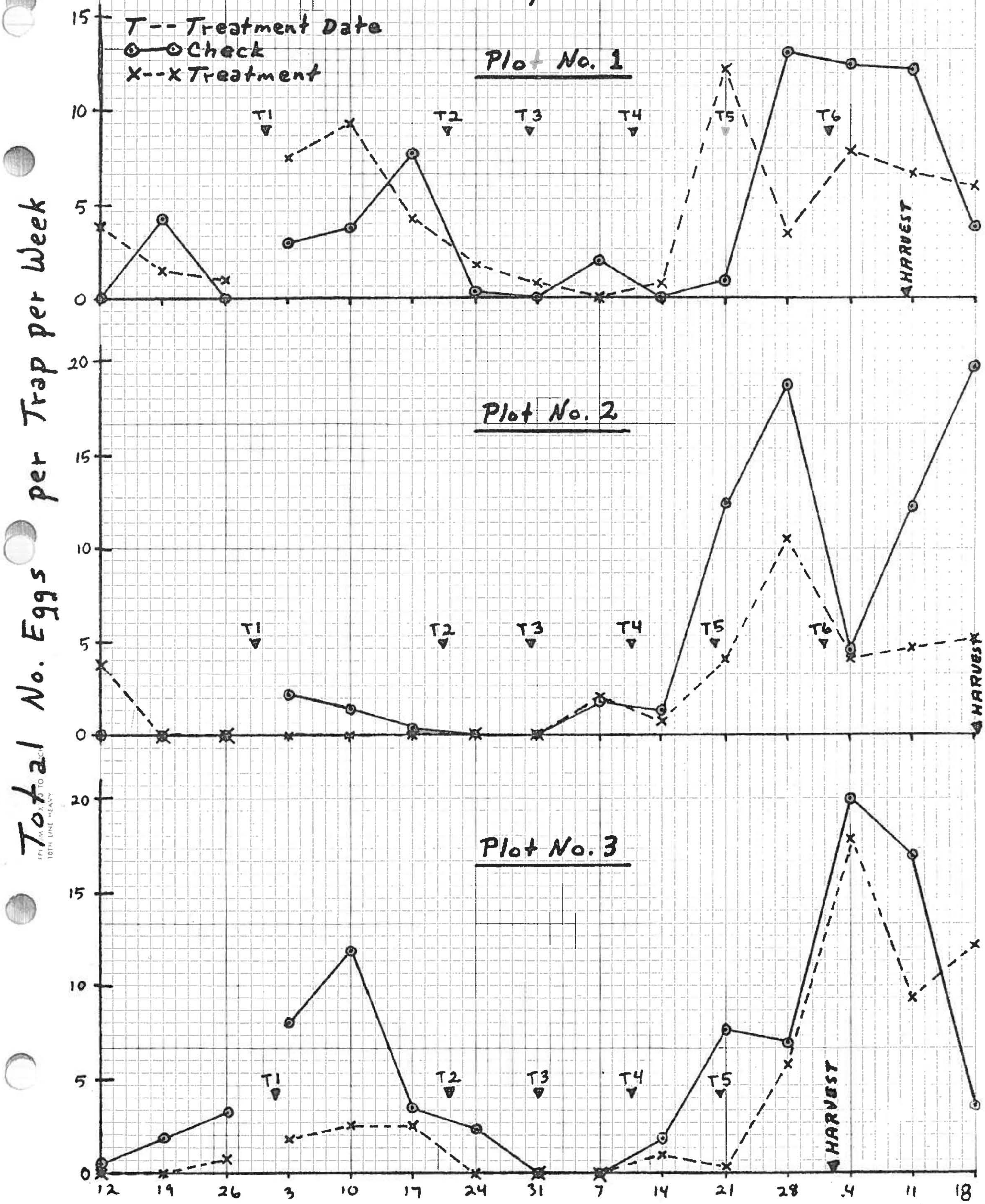


Figure 4. Cumulative NOW eggs laid on almond-meal-baited egg traps per week per trap in 20-acre plots treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

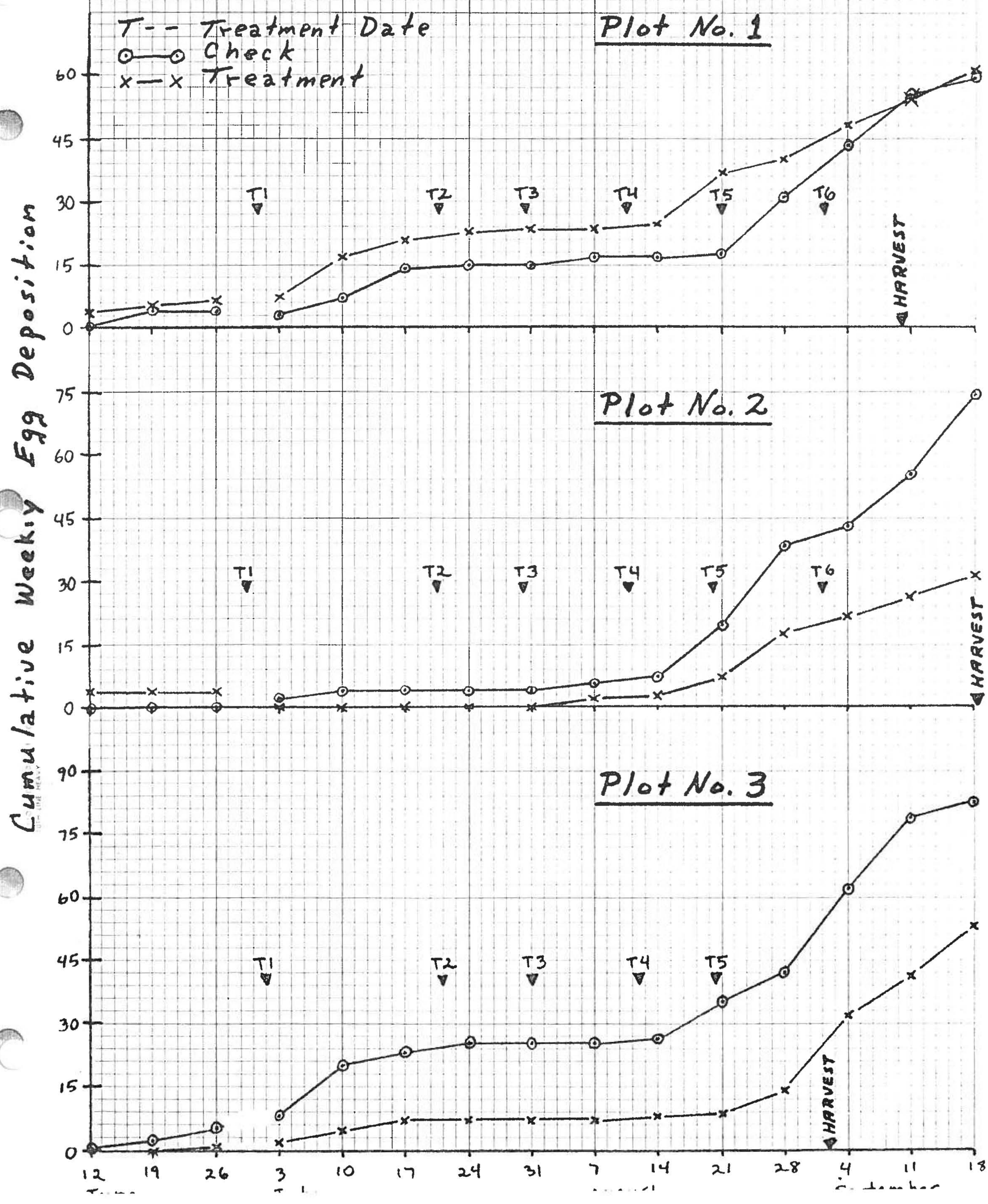


Figure 5. Total male catches in female-baited sticky traps per trap per week in Plot No. 1 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

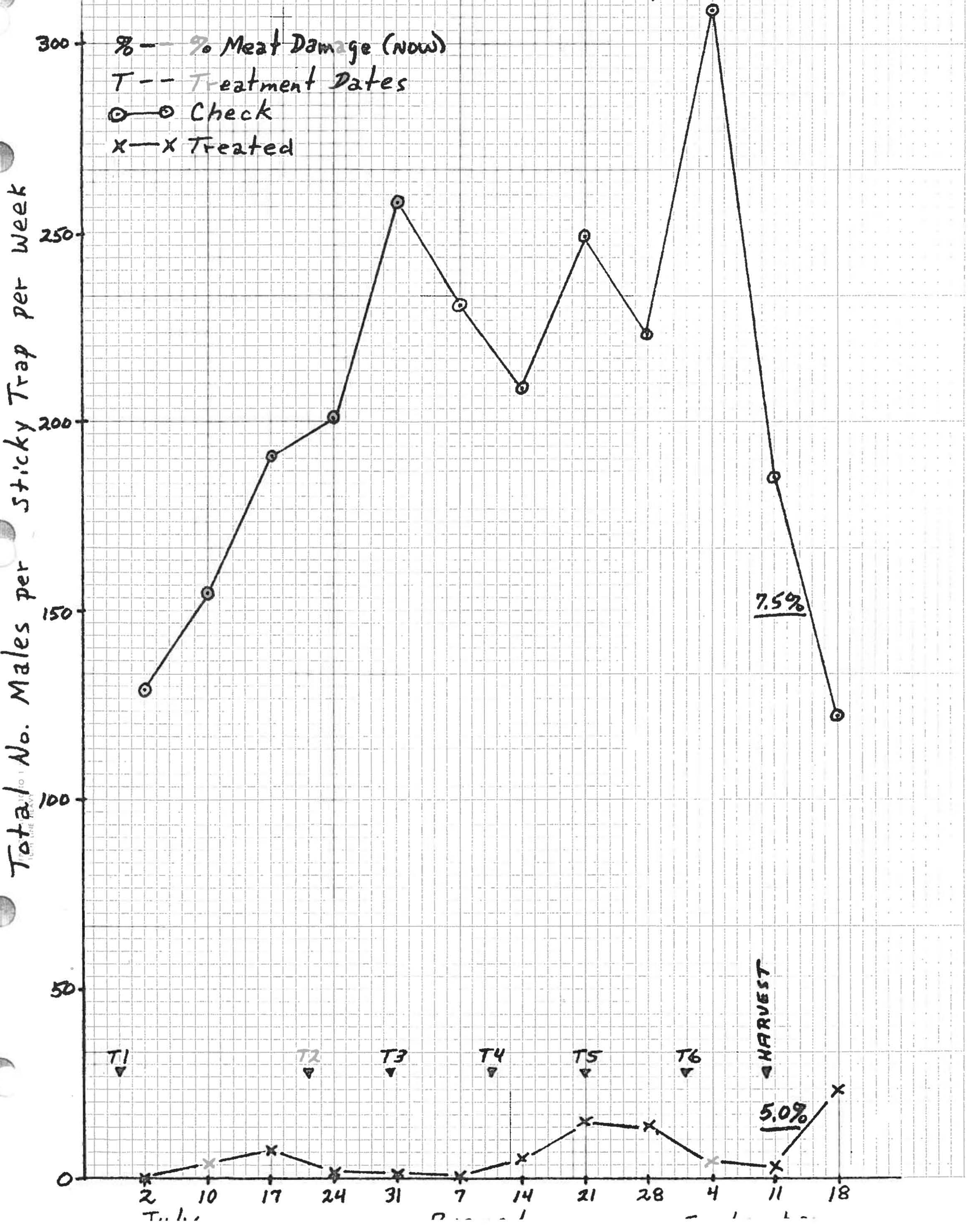


Figure 6. Total male catches in female-baited sticky traps per trap per week in Plot No. 2 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

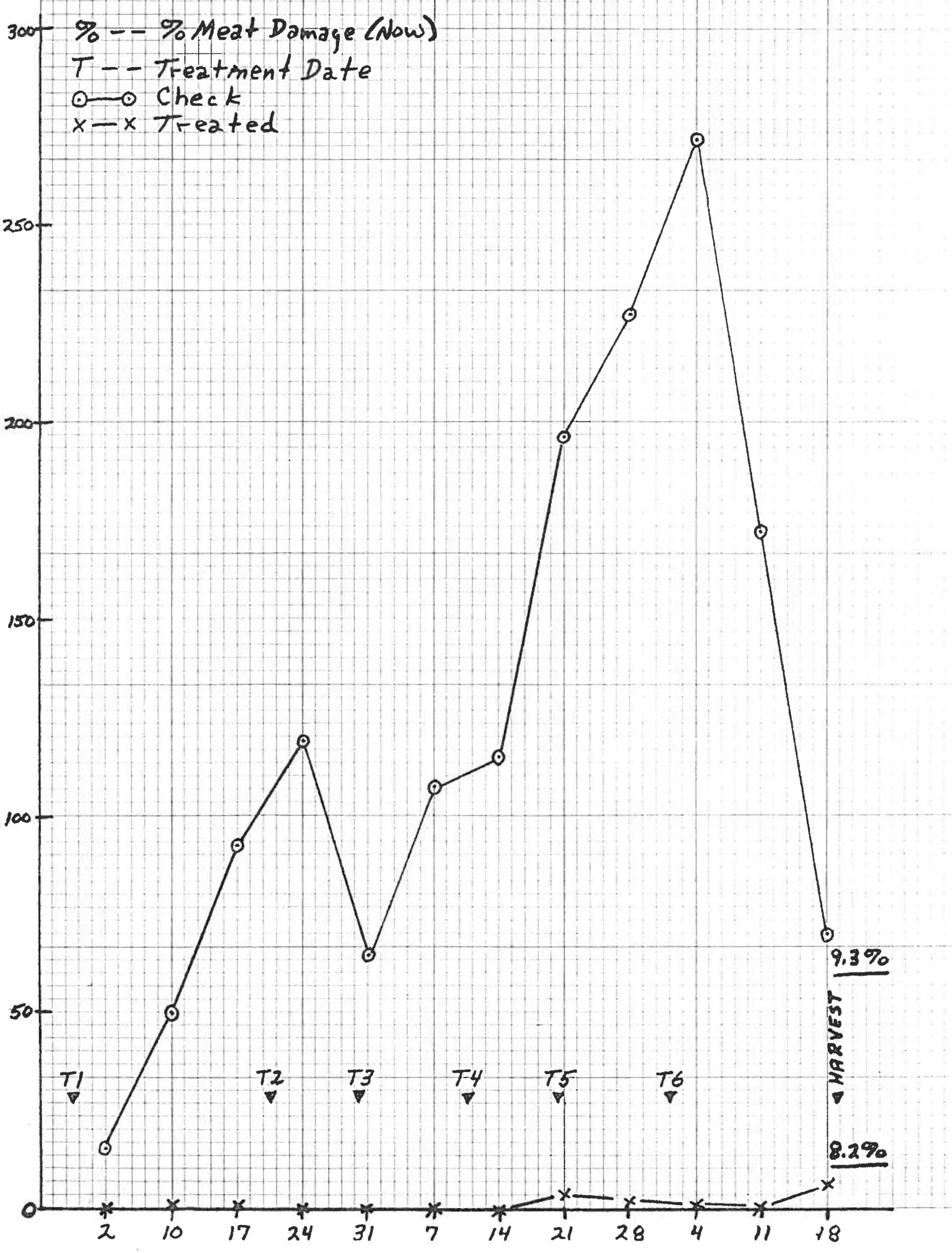


Figure 7. Total male catches in female-baited sticky traps per trap per week in Plot No. 3 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

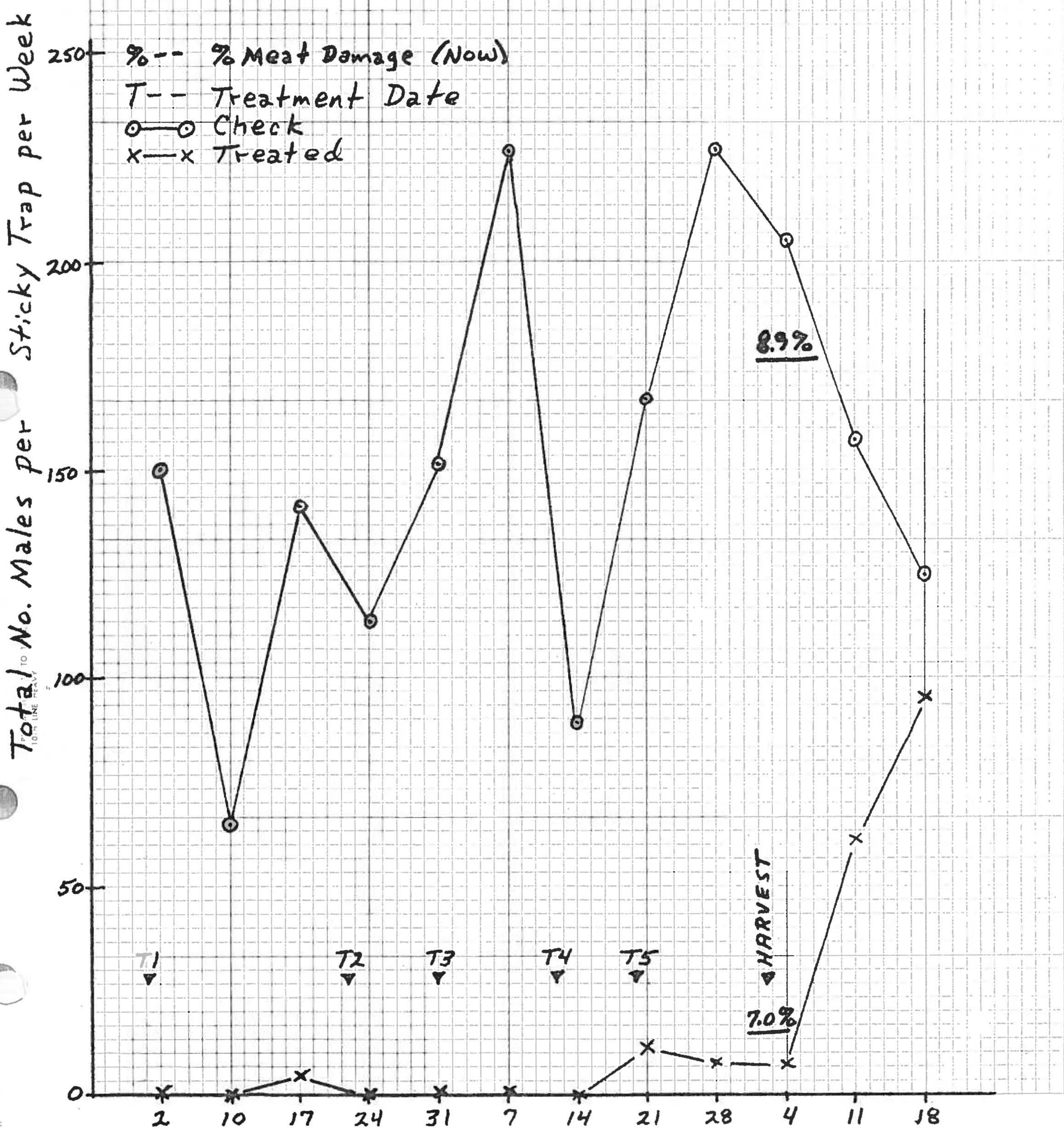


Figure 8. Cumulative male catch in female-baited sticky traps per week per trap in Plot No. 1 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

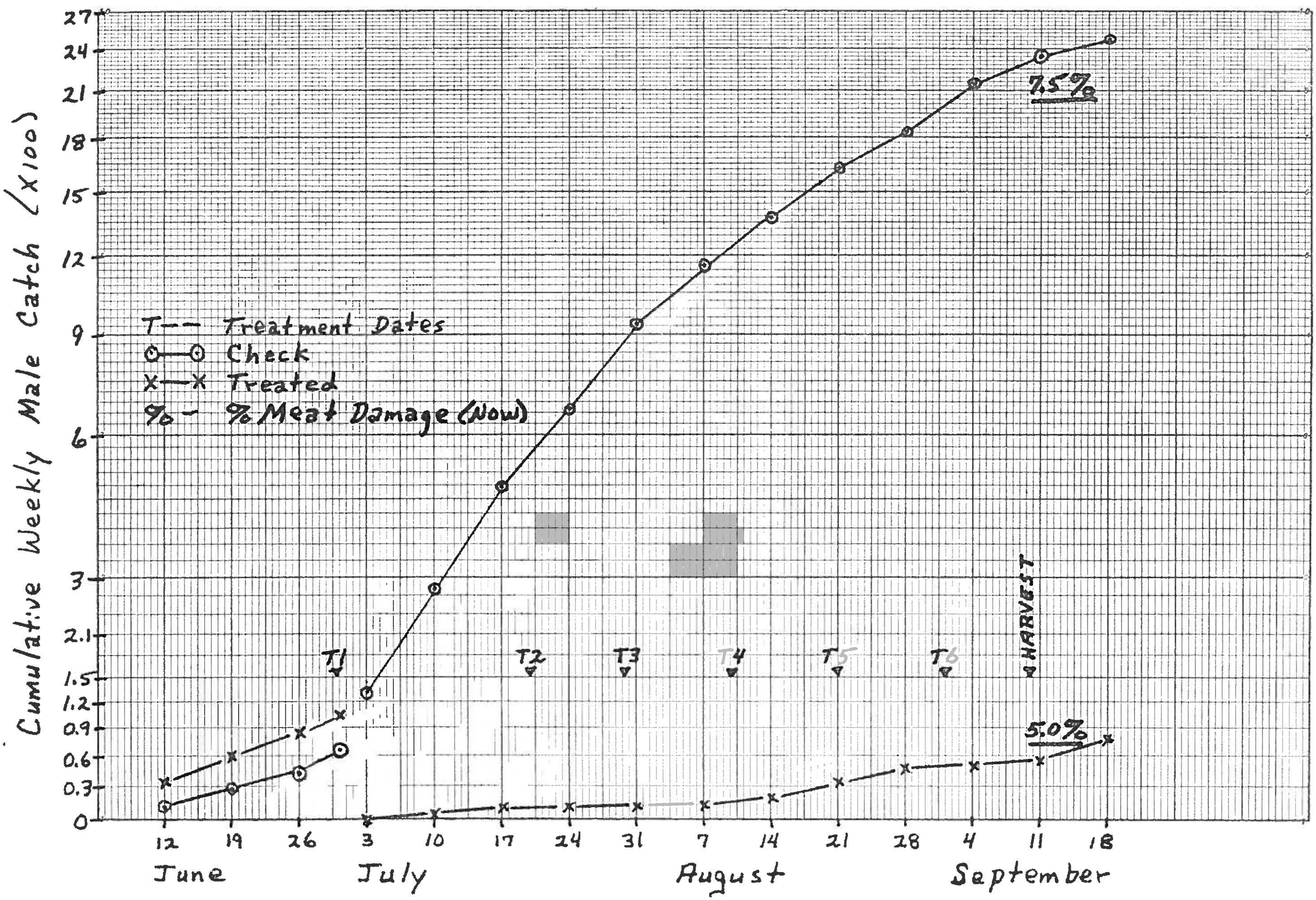


Figure 9. Cumulative male catch in female-baited sticky traps per week per trap in Plot No. 2 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

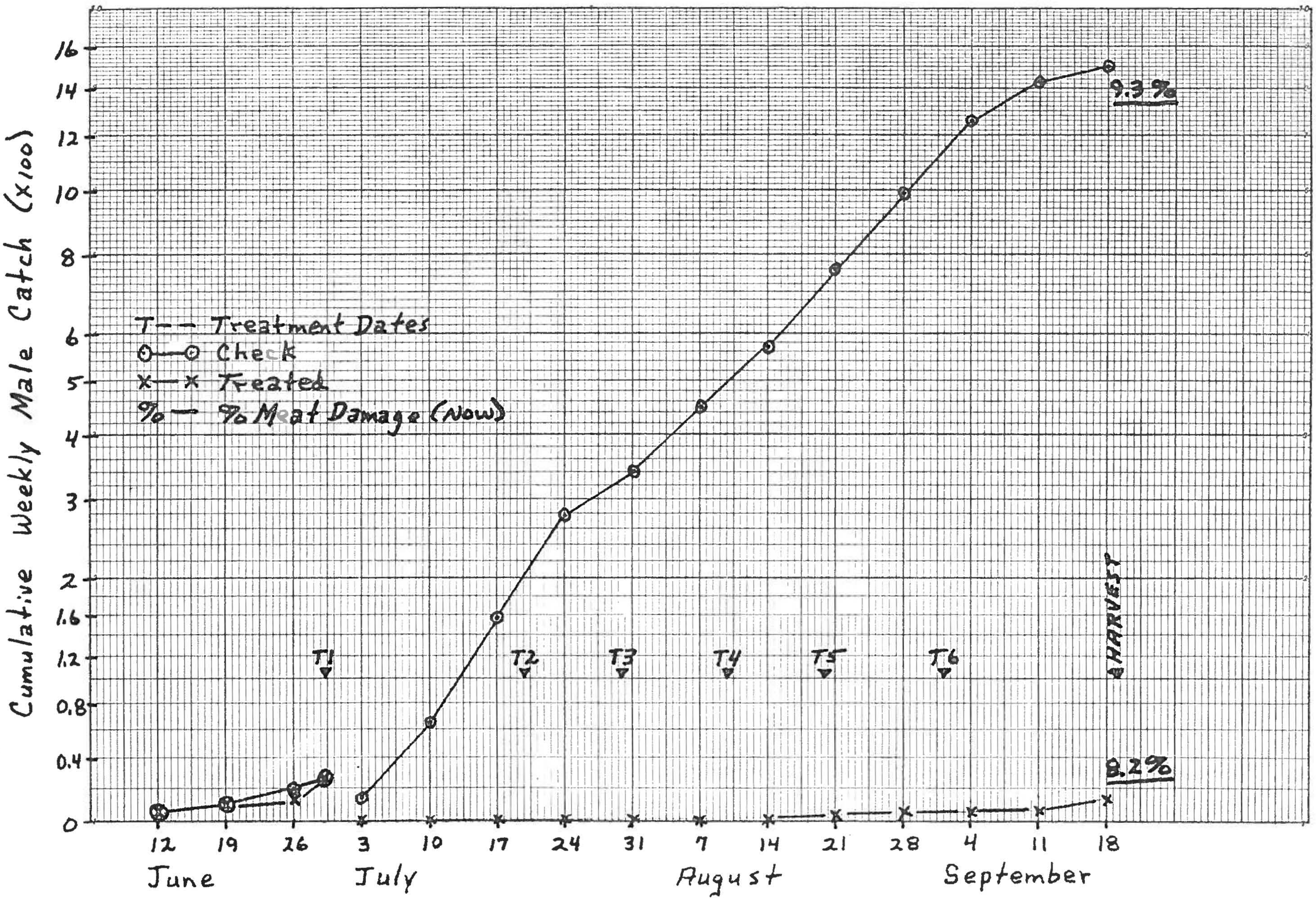


Figure 10. Cumulative male catch in female-baited sticky traps per week per trap in Plot No. 3 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

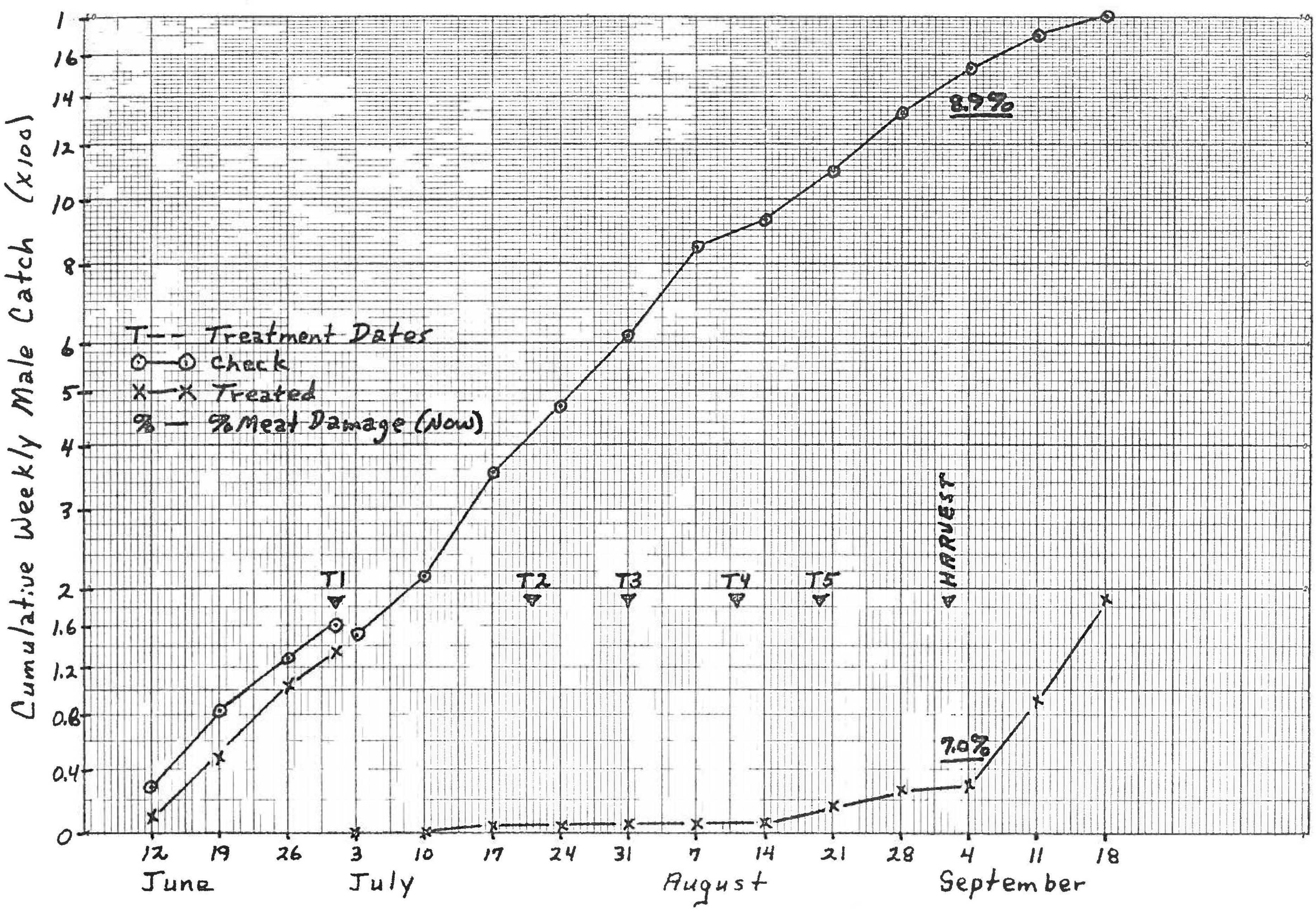


Figure 11. Total NOW moth catch for 2 black-light traps per week in Plot No. 1 treated with NOW aldehyde formulated in Hercon® laminates, Ballico, CA. 1981.

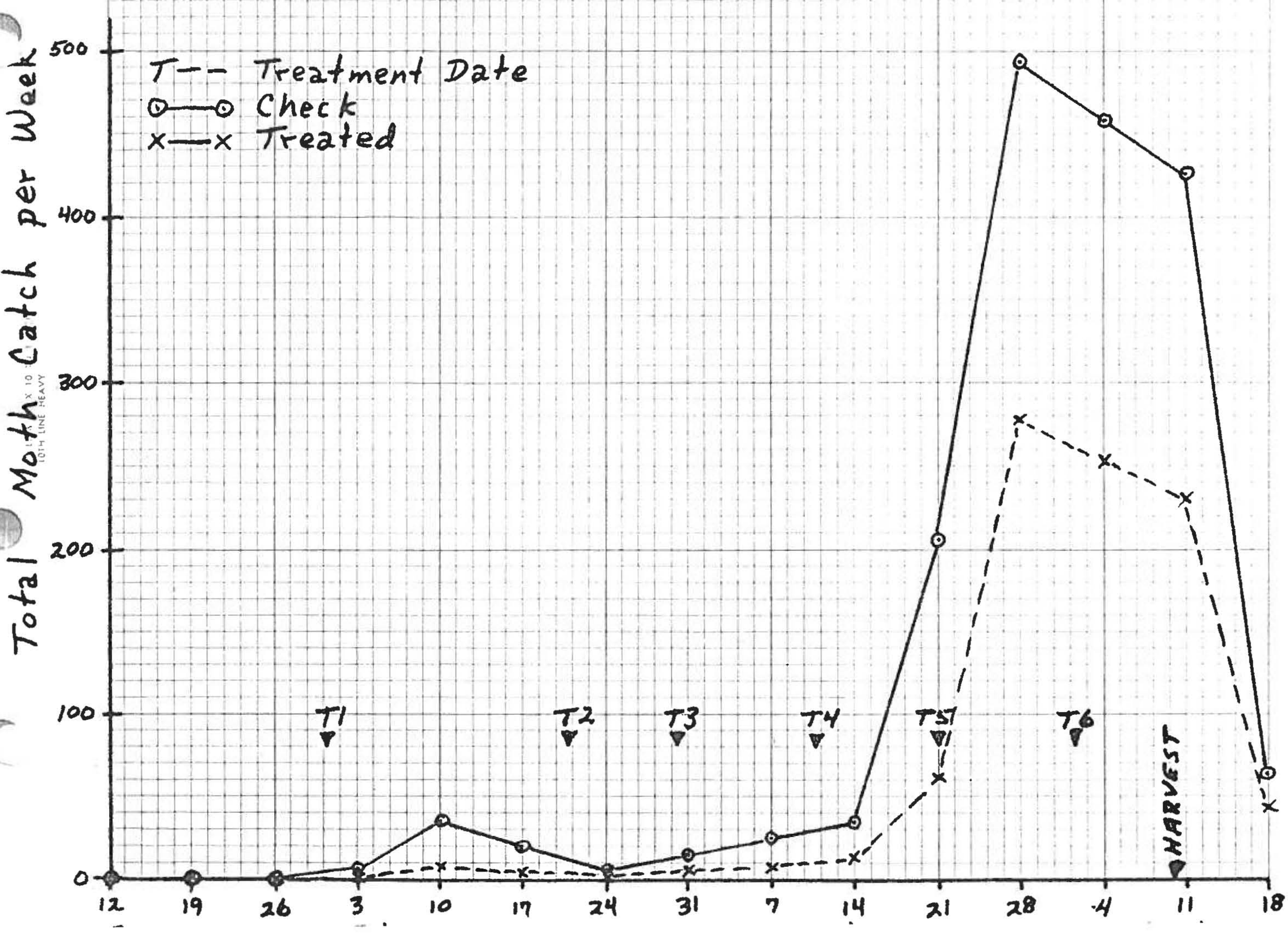


Figure 12. Total NOW moth catch for 2 black-light traps per week in Plot No. 2 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

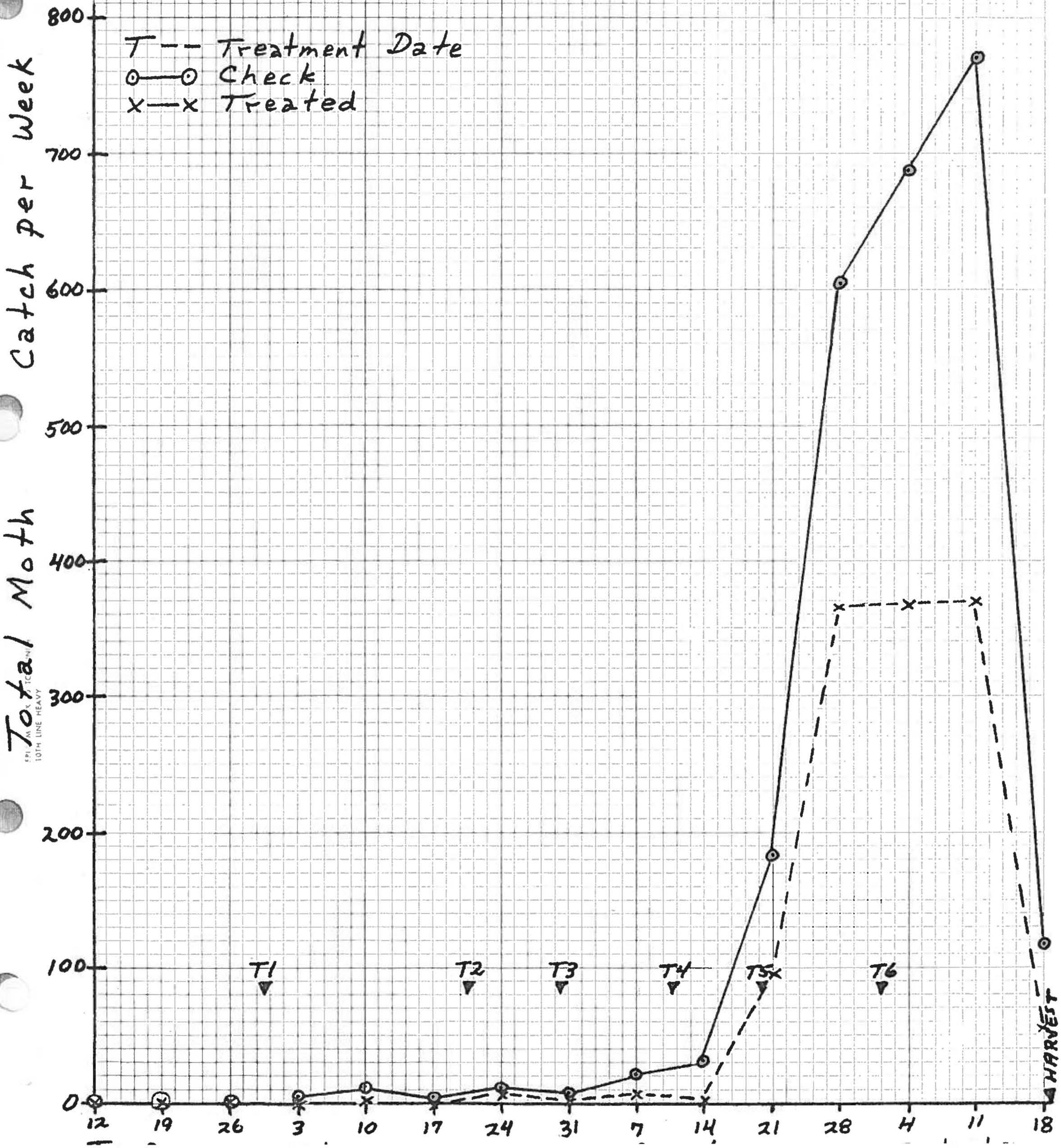
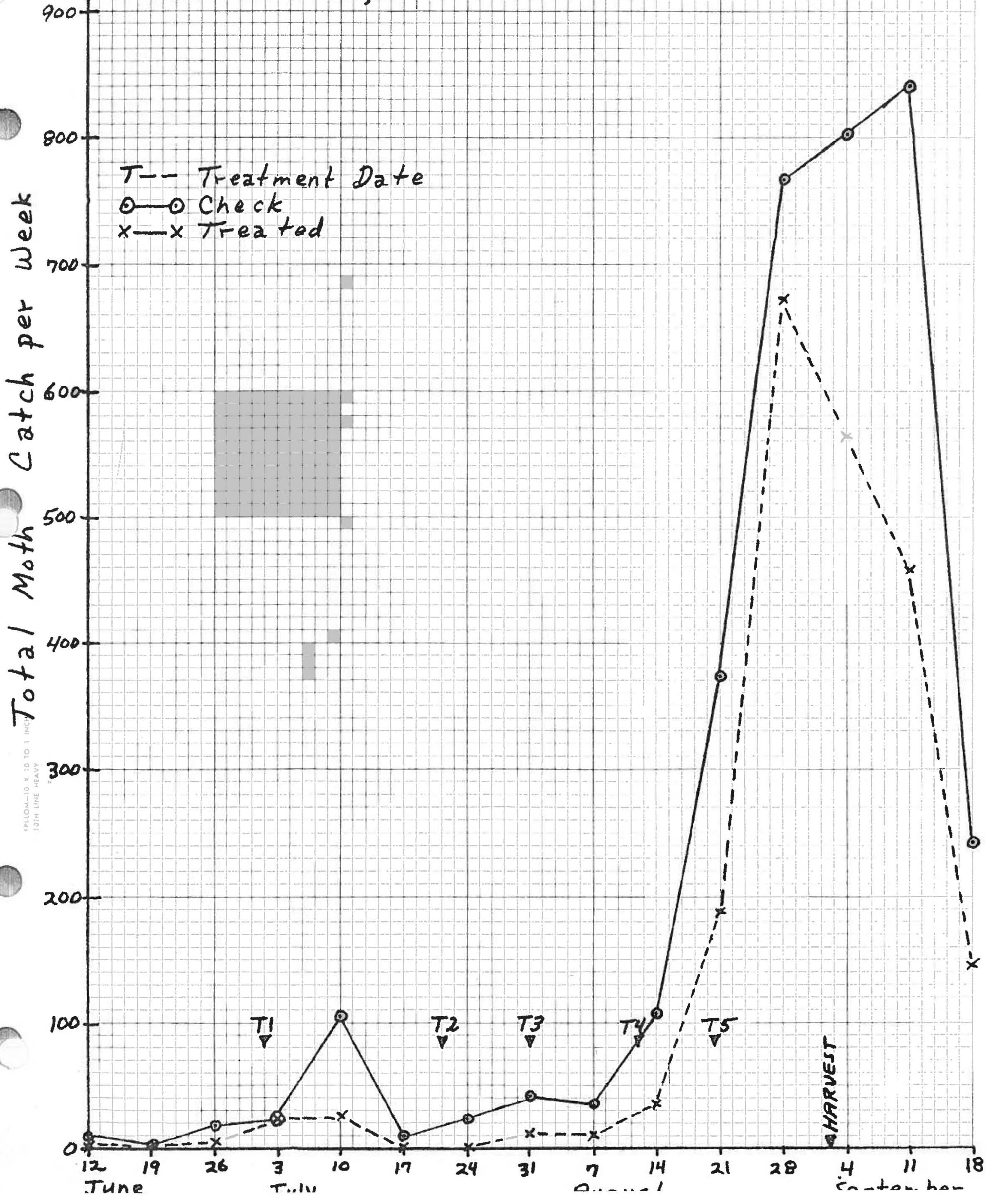


Figure 13. Total NOW moth catch for 2 black-light traps per week in Plot No. 3 treated with NOW aldehyde formulated in Hercon® laminates, Ballico, CA. 1981.



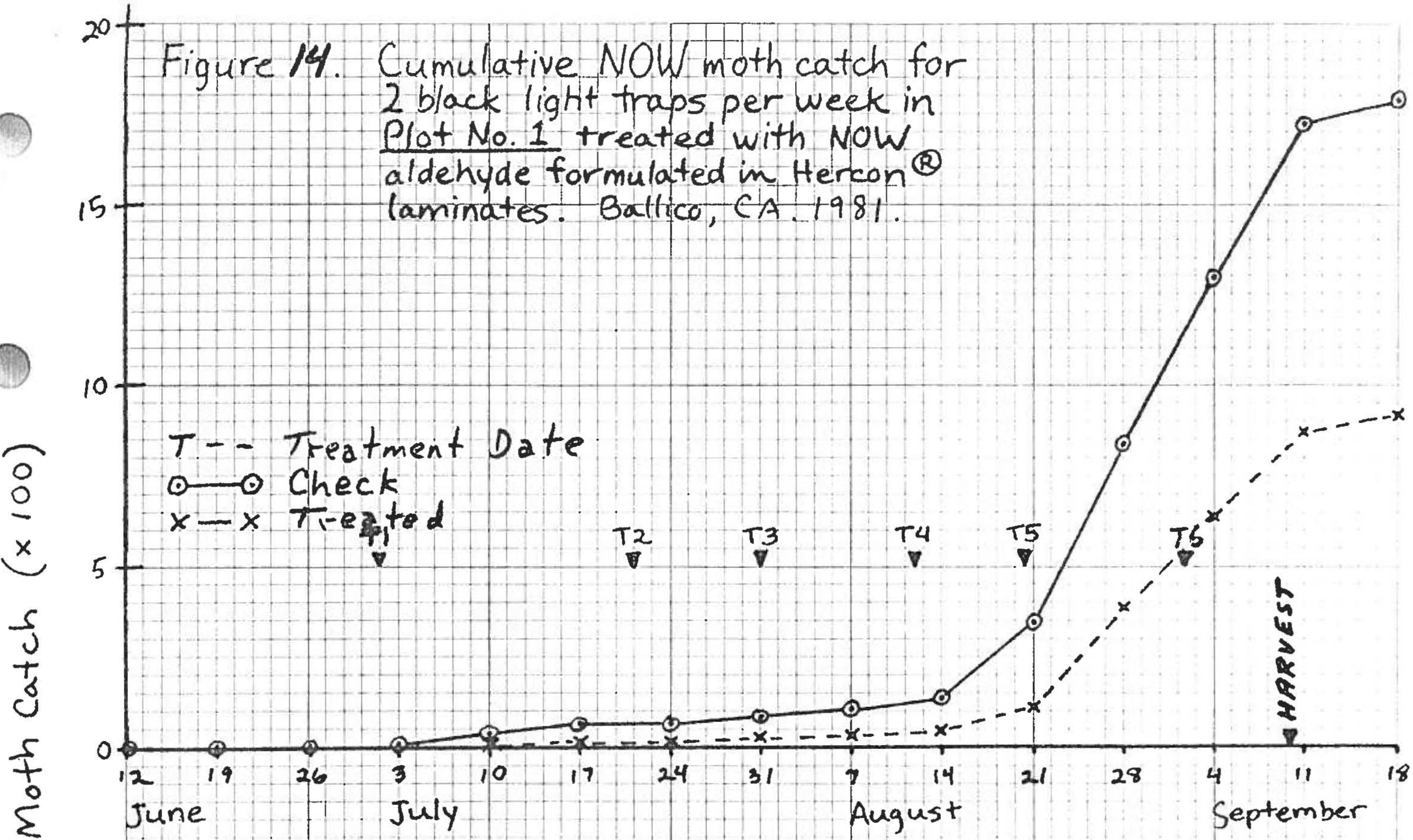


Figure 14. Cumulative NOW moth catch for 2 black light traps per week in Plot No. 1 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

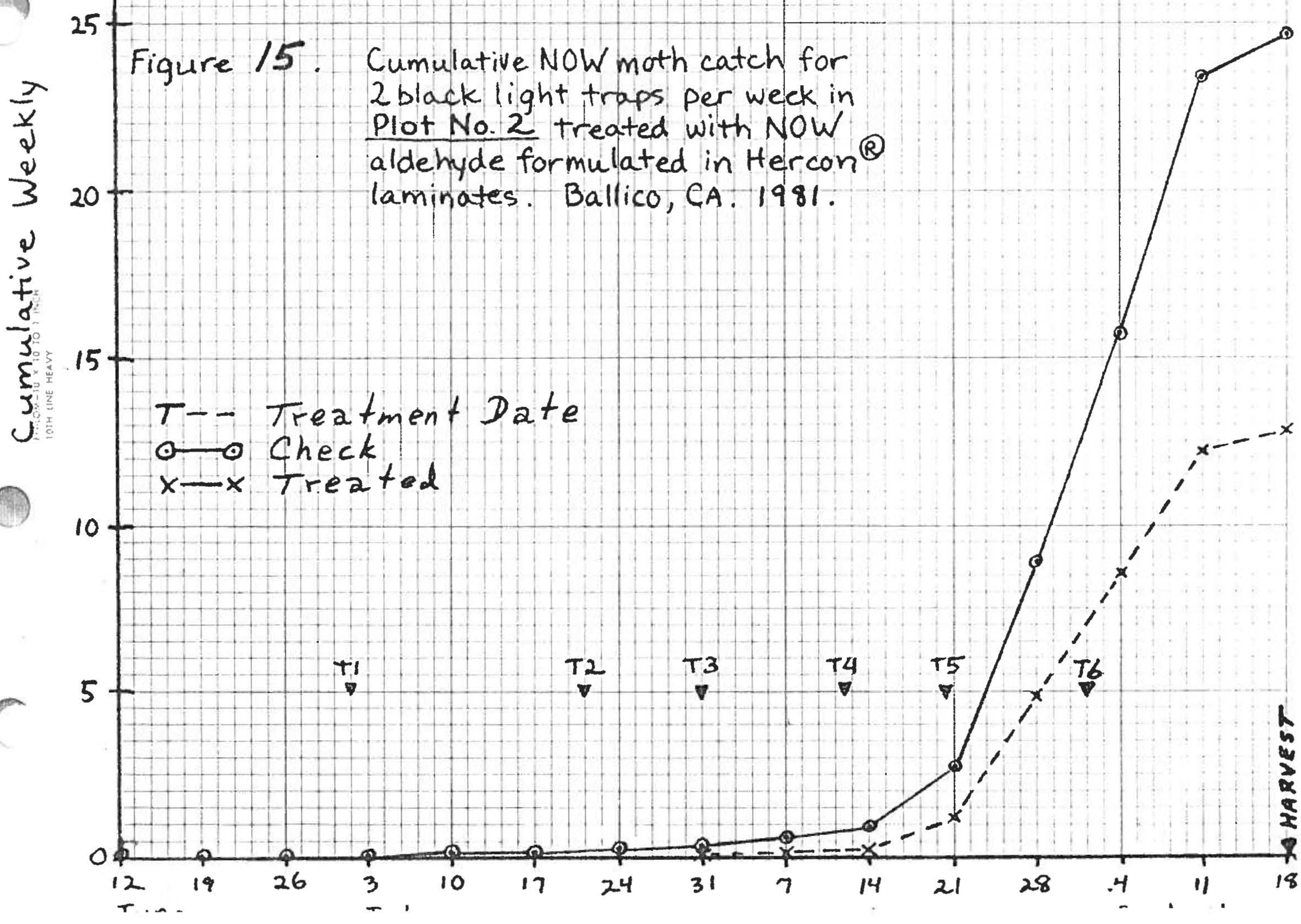


Figure 15. Cumulative NOW moth catch for 2 black light traps per week in Plot No. 2 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

Figure 16. Cumulative NOW moth catch for 2 black-light traps per week in Plot No. 3 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.

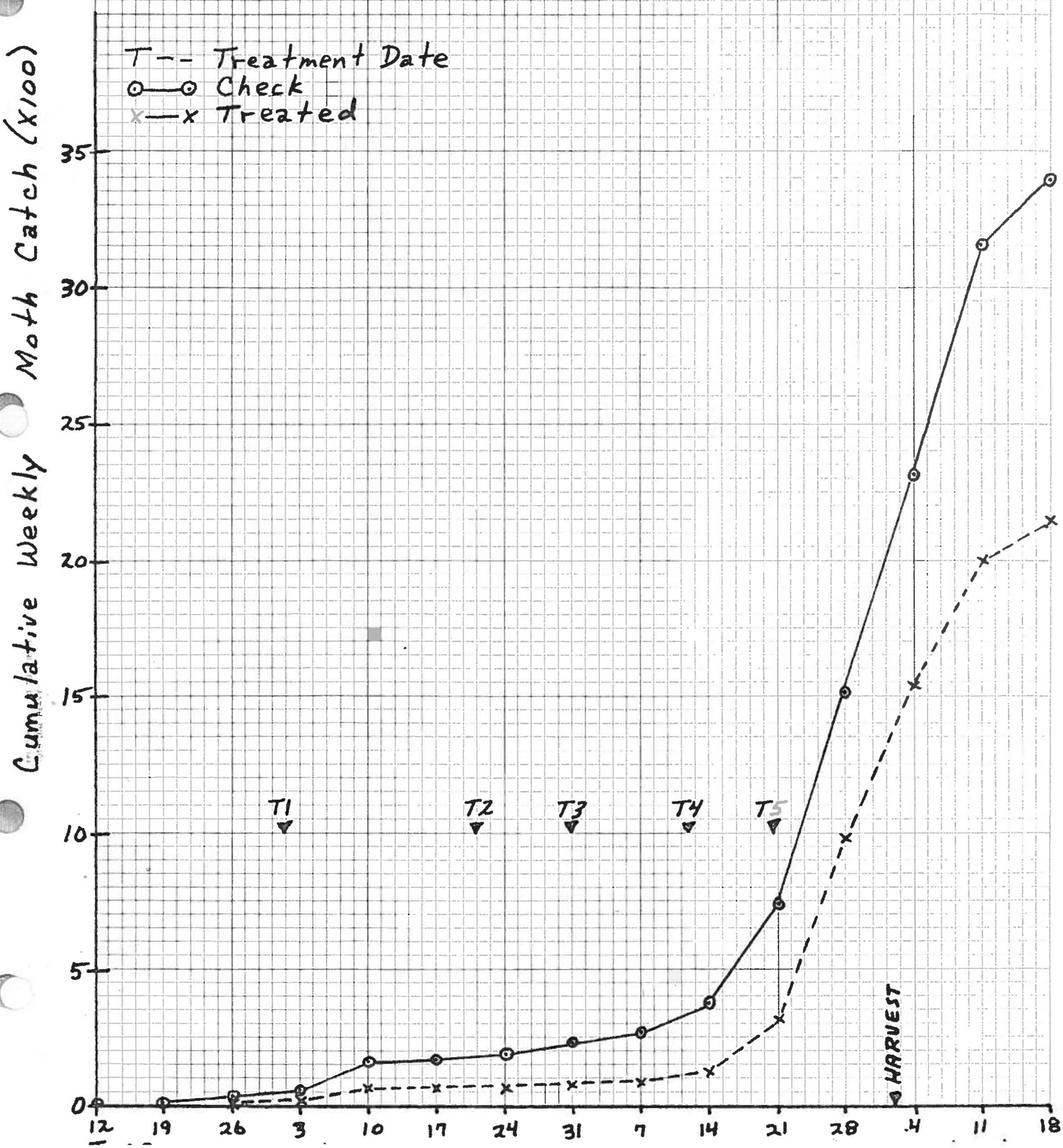
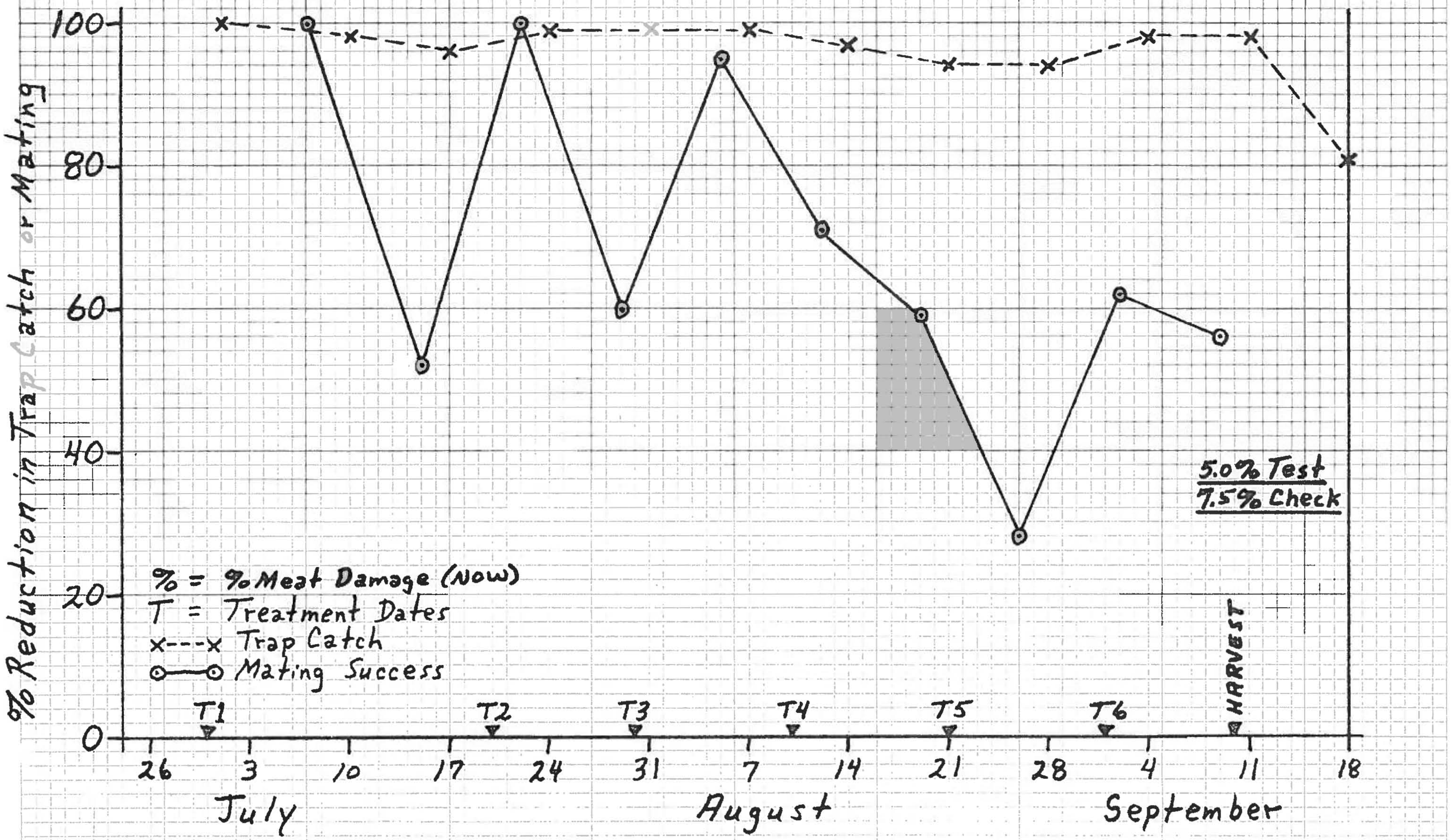
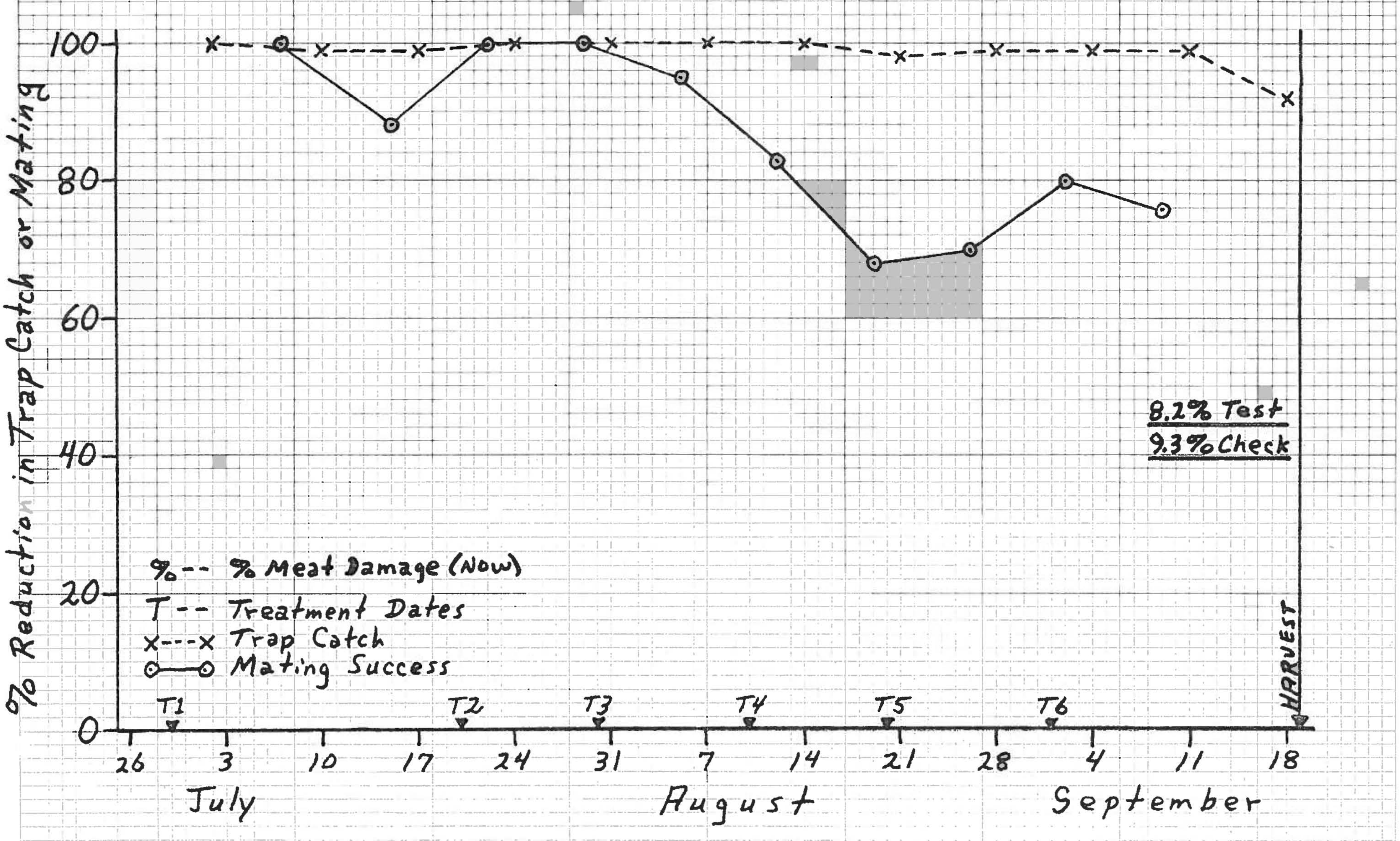


Figure 17. Percent reductions in male catches in female-baited sticky traps and percent reductions in mating success of females placed in Plot No. 1 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.



FPILOM-10 X 10 TO 1 INCH
10TH LINE HEAVY

Figure 18. Percent reductions in male catches in female-baited sticky traps and percent reductions in mating success of females placed in Plot No. 2 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.



FPI-LOM—10 X 10 TO 1 INCH 10TH LINE HEAVY

Figure 19. Percent reductions in male catches in female-baited sticky traps and percent reductions in mating success of females placed in Plot No. 3 treated with NOW aldehyde formulated in Hercon® laminates. Ballico, CA. 1981.