A PRELIMINARY REPORT ON THE 1991 TRIAL OF MATING DISRUPTION WITH AGRISENSE-BCS *H. ARMIGERA* PHEROMONE.

M.D. Betts[1], P.C. Gregg[1], G.P. Fitt[2] and M.J. MacQuillan[3]

[1] Department of Agronomy and Soil Science
University of New England, Armidale, NSW 2351

[2] CSIRO Division of Entomology
PO Box 59, Narrrabri, NSW 2390

[3] Dunluce International Pty. Ltd.
PO Box 44, Killara, NSW 2071

AIMS

The aims of the trial were:

1. To determine whether mating of *H. armigera* could be disrupted in cotton by mass release of pheromones.

2. If mating disruption was achieved, to determine the effects of this on the densities of eggs and larvae.

3. To observe the nocturnal behaviour of moths in pheromone treated and untreated fields in an attempt to understand the mechanism of mating disruption.

Trial site

The trial was located on a large cotton farm, Auscott Pty. Ltd. near Narrabri in northern NSW. Two fields on the northern edge of the property, comprising 77 and 48 ha, were used for the treated and control fields respectively. They were separated by a field containing *Dolichos lablab* and surrounded by fallow land (Fig. 1). The cotton variety was Sicala, and the plants were in the flowering and boll setting stage at the start of the trial.

METHODS

Disruption pheromones

Agrisense-BCS Selibate^{TM} strips were inserted at the top of split bamboo stakes placed in the ground so that the dispensers were at terminal height (about 80cm). The northernmost 30 ha of the treated field was covered with 500 strips /ha., spaced evenly and giving a pheromone rate of 40 mg/ha. Pheromones were put in place on 5-6/2/91 and removed on 6-7/3/91.

Pheromone trapping

In each field, 6 *H. armigera* and 2 *H. punctigera* traps, of the Texas design, were operated in the northern part of the field. Two were in the centre of the field and 4 on the edges. A further trap for each species was operated in the southern part of the field (Fig. 2). Traps were cleared daily in most cases, although in some instances clearing intervals were extended for up to a few days. Trapping began on 18/1/91, 19 days before pheromone dispensers were put in place, but some *H. punctigera* traps, and the southern traps for both species, were not installed until shortly after the pheromones went in. Trapping ceased on 21/3/91, 14 days after removal of the pheromones. Lures for both species were Hercon^{R} plastic laminates.

Light trapping

Light traps using 6 watt BL fluorescent tubes were placed in the centre and on the edges of both fields (Fig. 2). The catch was collected into 70% ethanol and segregated on a daily basis in most cases. Light trapping was commenced on 18/1/91 and ceased on 15/3/91.

Captive virgin females

Laboratory reared virgin *H. armigera* females aged 2-4 days, with one wing removed to prevent escape, were placed in trays at terminal height. In each field, 25 trays were located near the centre of the northern area (Fig. 2). Females were put in place near sunset and collected early the next morning. They were then dissected to determine the incidence of mating on the basis of the presence of spermatophores.

This was done on 2 occasions before the pheromones were put in place, on 5 occasions when they were present, and 3 occasions after they were removed.

Night vision observations

Two west-east transects in each field, near the centre of the northern section, were marked at intervals of 100m by flags (Fig. 2). Observers with night vision glasses and infra-red headlamps walked these transects repeatedly from shortly after sunset until shortly before sunrise. The number of *Heliothis*-sized moths seen flying at distances of up to 20m from the observer was recorded for each 100m interval. Notes were made on the type of flight behaviour. When the observer passed a captive female, the presence or absence of calling was noted. Calling is the extrusion of the ovipositor, and indicates pheromone release.

Night vision observations were made on two nights, 25-26/2/91 and 5-6/3/91.

Counting eggs and larvae

Eggs and larvae were sampled using the SIRATAC stratified random method, in which the top 12 cm of 8 groups of 5 plants were checked in each field. All eggs and larvae found were reared for species identification. Sampling was conducted on 3 occasions before the pheromones were put in place, and on 5 occasions when they were present.

RESULTS

Pheromone trapping - *H. armigera*

Catches of *H. armigera* from the centre pheromone traps in each field are shown in Fig. 3a. Catches were similar in both fields until the pheromones were put in place. Catches in the treated field then fell to almost zero, while those in the control field rose to higher levels. While the pheromones were in place, only 2 moths were caught in the treated field compared to a total of 1096 in the control field.

After removal of the pheromones, a few *H. armigera* were caught in the treated field. However, catches had not increased to the levels of the control field after a further 11 days.

Pheromone trapping - *H. punctigera*

Since the original aims of the trial did not include checking for mating disruption of this species, only one trap was initially operated in each field. An additional trap was added when it seemed likely that effects were occurring. Results from these traps are shown in Fig. 3b. As with *H. armigera*, there was a substantial suppression of trap catches during the period when pheromones were present. Over this time, 5 *H. punctigera* were caught in the treated field compared with 686 in the control field.

In contrast to *H. armigera*, when the pheromones were removed, the catches of *H. punctigera* in the treated field increased quickly to levels similar to those in the control field.

Mating of captive females

The overall rate of recovery of females (89%) did not differ significantly between the two fields. The remaining 11% either escaped or were taken by predators overnight. On one occasion, captive females were affected by the residual activity from a recently applied insecticide, and many died. These results have been discarded. The remaining data are shown in Fig. 4.

Before the pheromones were in place, no mating occurred in captive females from either field. This is probably because, at the times when these females were exposed, very few males were present. Pheromone catches were very low (compare Figs. 4 and 3a).

While the pheromones were present, no mating of captive females occurred in the treated field (Fig. 4). In the control field, however, mating ranged from 25-40%. After removal of the pheromones, mating was detected among females from the treated field. The percent mating was lower than in the control field, but not significantly so.

Females called in both fields. Observations with night vision glasses showed calling in 39% of observations in the control field and 27% in the treated field. This difference is

not statistically significant ($p = 0.09$). The true incidence of calling is undoubtedly higher than this, because each moth was observed only briefly and calling is an intermittent activity.

Counts of eggs and larvae

The counts of eggs and larvae are shown in Fig. 5. Low numbers were present in both fields at the start of the trial, but increased in both fields during the presence of the pheromones. On most occasions there was no significant difference between the numbers of eggs and larvae in the two fields. The farm management considered it necessary to spray both fields with insecticides on 2 occasions while the pheromones were present (13/2/91 and 18/2/91).

Only at the last sample was there a substantial difference in the numbers of eggs and larvae between the fields, and it was the treated field which had the higher numbers (Fig. 5). The reason for this is not clear, but this was the only sample at which a major management difference existed between the fields. The control field had been irrigated just before this sample, but the treated field had not.

Night vision observations

Similar numbers of *Heliothis*-sized moths were seen in both fields on both nights (Figs. 6 and 7), but in the control field moths seemed to be distributed throughout the field while in the treated field they were often concentrated at the edges. This effect was most marked after midnight, when statistically significant differences between 100m sections of the field were recorded on both nights. The relative lack of moths in the centre of the treated field seemed to be due to a shortage of males. Male searching behaviour (rapid, straight, low level flight) was often seen throughout the control field, especially after midnight. In the treated field, however, this type of flight was only seen around the edges. Most moths seen in the centre, especially after midnight, appeared to have been flushed from the cotton by the approach of the observer, and were probably females.

Data still to be collected and analysed

We are still sorting light trap catches and it is too early to draw any conclusions from the data. Hopefully the light trap results will provide information on the numbers of mated females entering the fields and on the sex ratios within and on the edges of the fields. Similarly, data from the pheromone traps around the edges of the field have not been analysed yet. Catches are generally lower than in the centre traps in the control field, but higher than in the centre of the treated field. The species composition of the eggs and larvae sampled from both fields will not be known until rearing is completed. This information may modify the conclusion that there was little effect of pheromones on oviposition. Data from the light traps, the edge pheromone traps and the rearing results will be incorporated in a final report within the next 2 months.

CONCLUSIONS

The pheromones clearly suppressed mating in the treated field. As judged by trap catches, the suppression was 99.8% for *H. armigera* and 99.3% for *H. punctigera*. As judged by the captive females, the suppression of mating in *H. armigera* was total.

However, suppression of mating within the field was not translated into reduced oviposition. No significant differences in total counts were recorded between control and treated fields for most of the time when pheromones were present. There was an increase in counts in the treated field at the end, but it was probably unrelated to pheromones. The general lack of an effect on oviposition is probably because mated females flew into the treated crop from surrounding cotton, from the *Dolichos lablab*, and from non-crop hosts. The light trap catches should provide some information on the numbers of mated females present.

The spatial effects observed with night vision glasses suggest that the suppression of mating was probably achieved because males were not attracted to, and perhaps were repelled from, the treated field, rather than because they were searching unsuccessfully within the field.

RECOMMENDATIONS

If the failure to suppress oviposition in this trial was due to immigration of mated females, a key question is: "what sized area must be treated to prevent this?". We believe the answer to this question will ultimately determine whether mating disruption is a feasible method of control for *Heliothis* spp. We see no real way of answering the question other than by large scale field trials. Trials on areas measured in km^2 rather than hectares will be needed. We therefore suggest that priority be given to the development and testing of a formulation and a method of application which will make such large scale trials economical and practical.

The effectiveness of the pheromone in suppressing *H. punctigera* catches was unexpected. This greatly adds to the potential value of mating disruption in Australian cotton. *H. armigera* is causing concern due to resistance, but it is probable that more insecticide is directed at *H. punctigera* in Australian cotton. Moreover, the major chemical used against *H. punctigera* (endosulfan) is being criticised on environmental grounds. Thus, a method that worked against both species would be very useful. We suggest that adequate monitoring, including the use of captive females, be incorporated for *H. punctigera* in future trials.

Finally, the night vision observations suggest that the mechanism of mating disruption might be repulsion rather than confusion of the males. If this could be verified, it might have many implications for mating disruption in *Heliothis* spp. and other insects. We suggest that future studies should continue to include this type of work.

TRIAL SITE

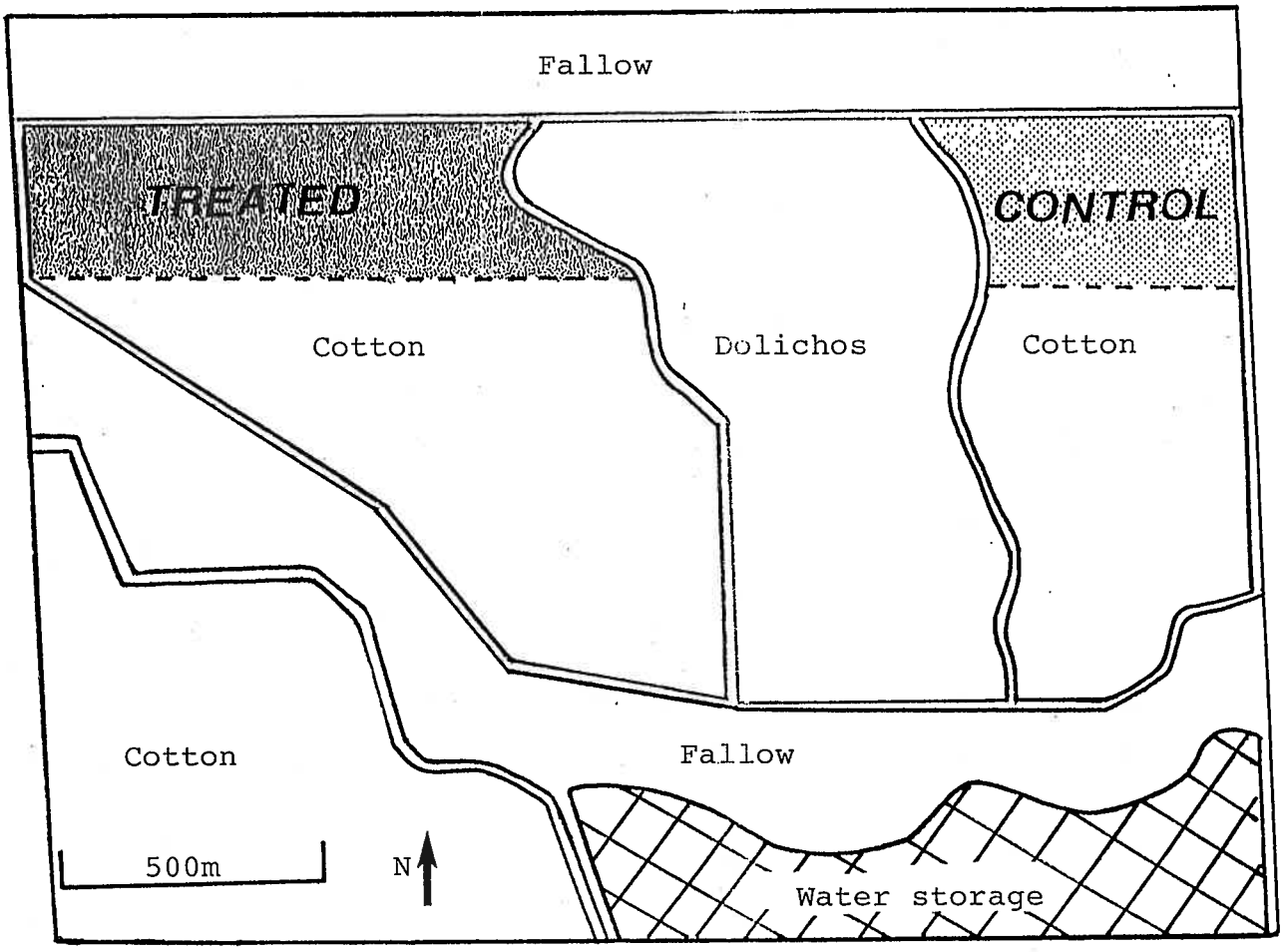

Figure 1. The trial site on the property of Auscott Pty. Ltd., Narrabri.

LAYOUT OF TRAPS IN THE CONTROL FIELD

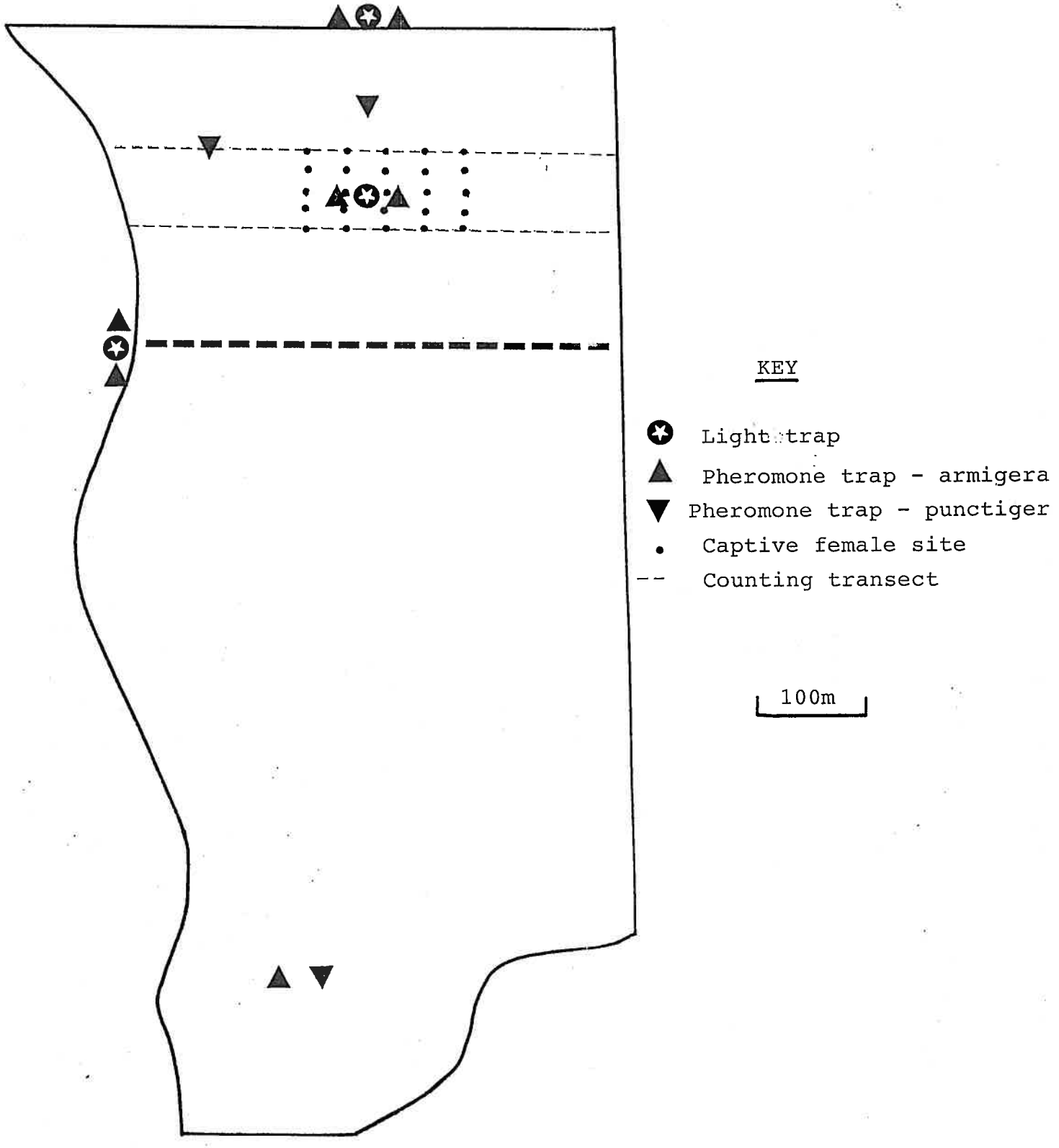

Figure 2. Layout of the traps, captive female trays and night vision transects in the control field. The layout in the treated field was similar.

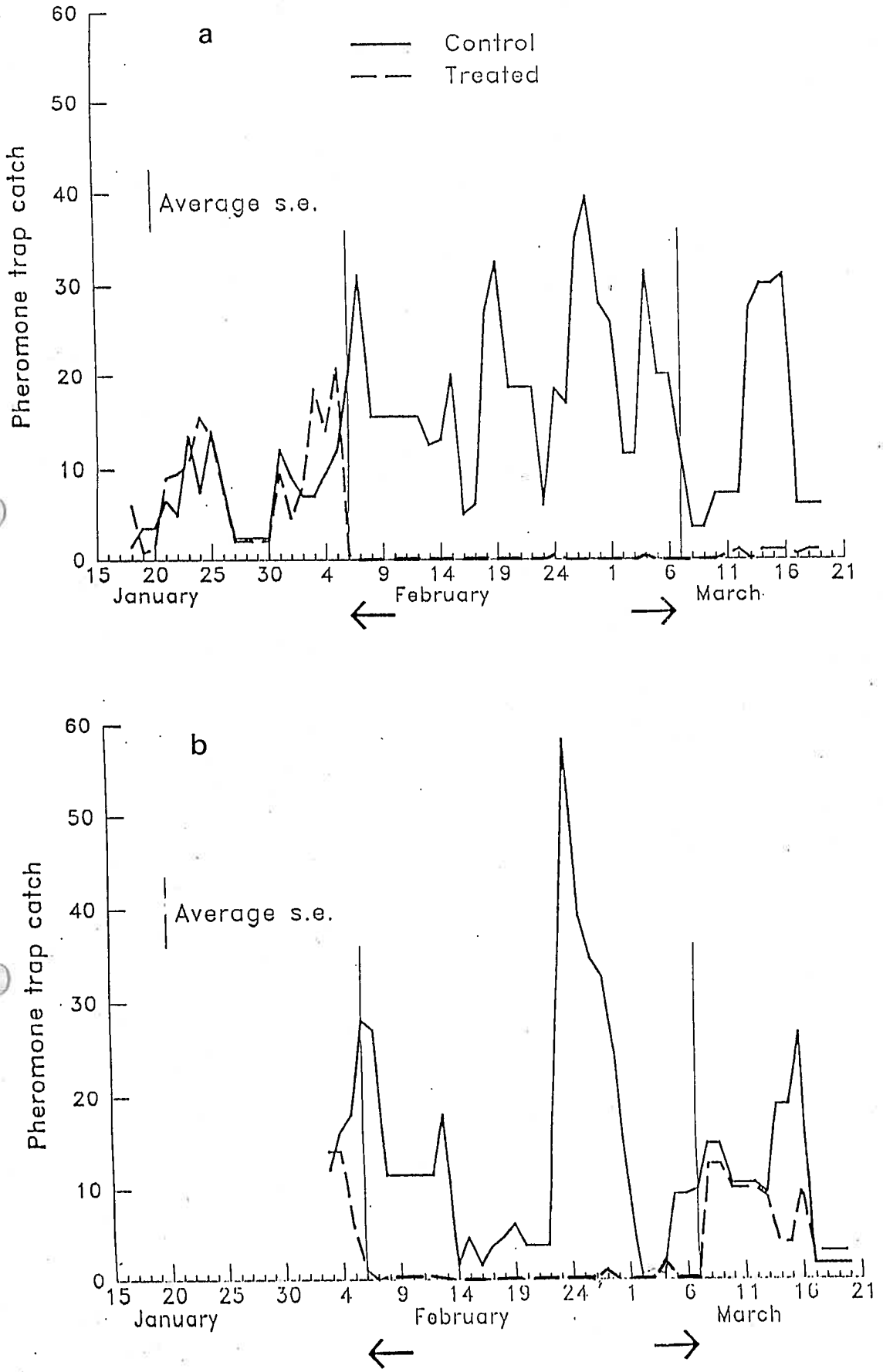

Figure 3. Catches from the pheromone traps within the fields at the northern ends. Mean of 2 traps. Arrows indicate when pheromones were present.
(a) = H. armigera
(b) = H. punctigera

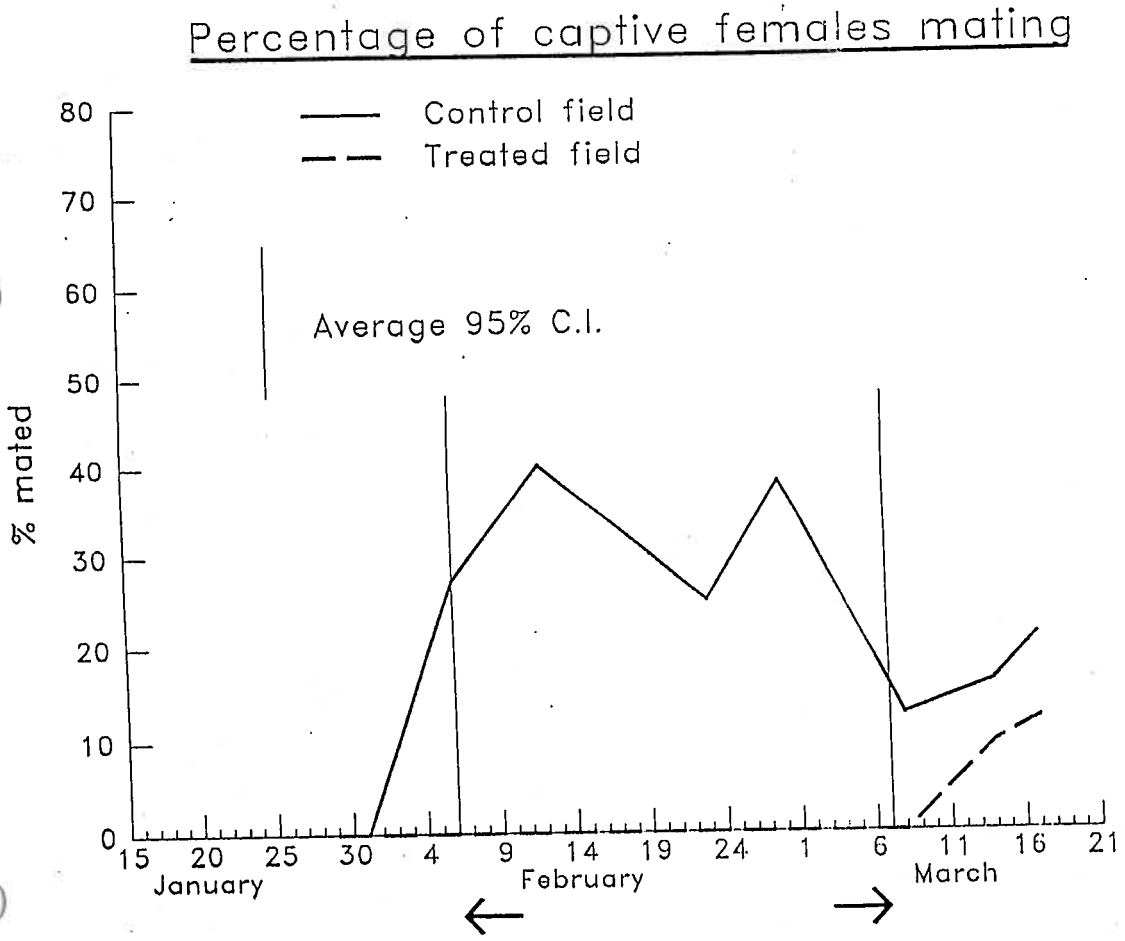

Figure 4. Percentage of captive virgin females mated after overnight exposure. N for each field ranged from 16 to 25. Arrows indicate when pheromones were present.

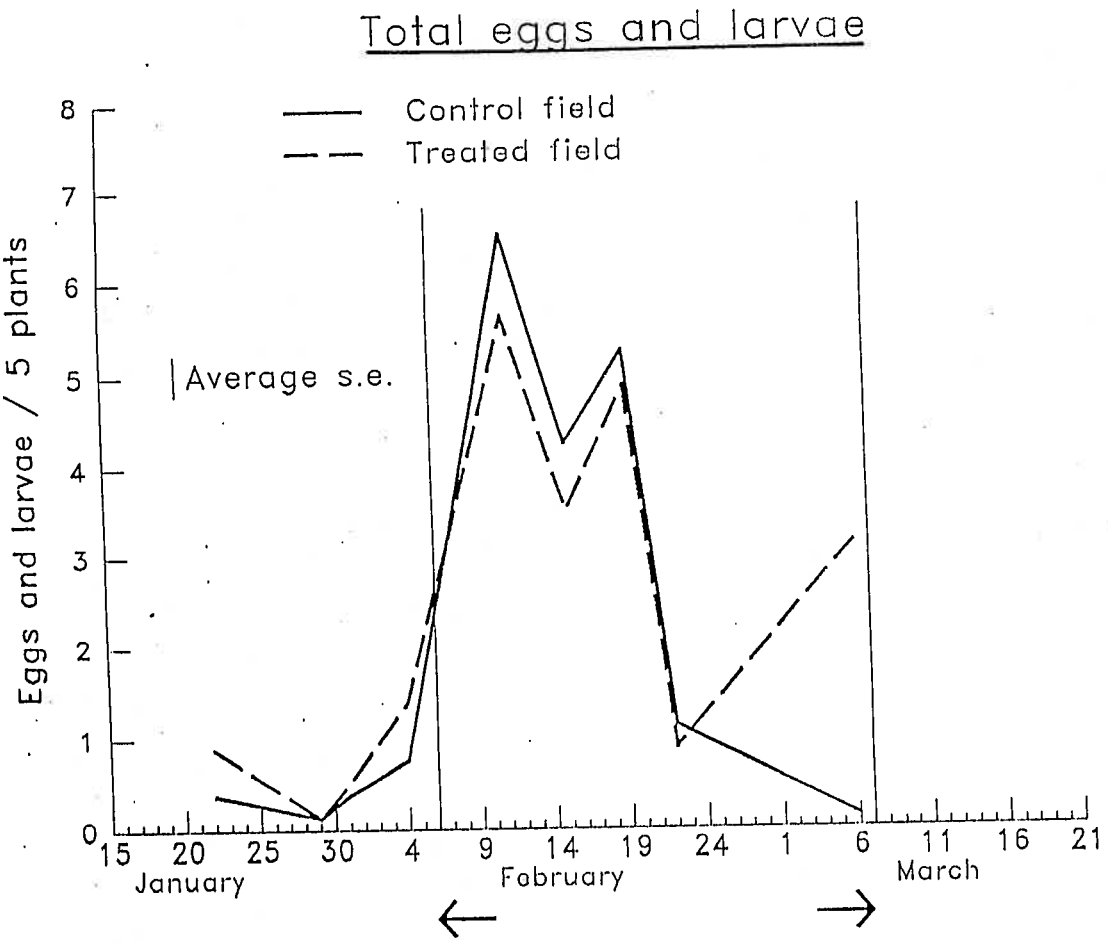

Figure 5. Total eggs and larvae per 5 plants. Each sample consisted of 8 groups of 5 plants. Arrows indicate when pheromones were present.

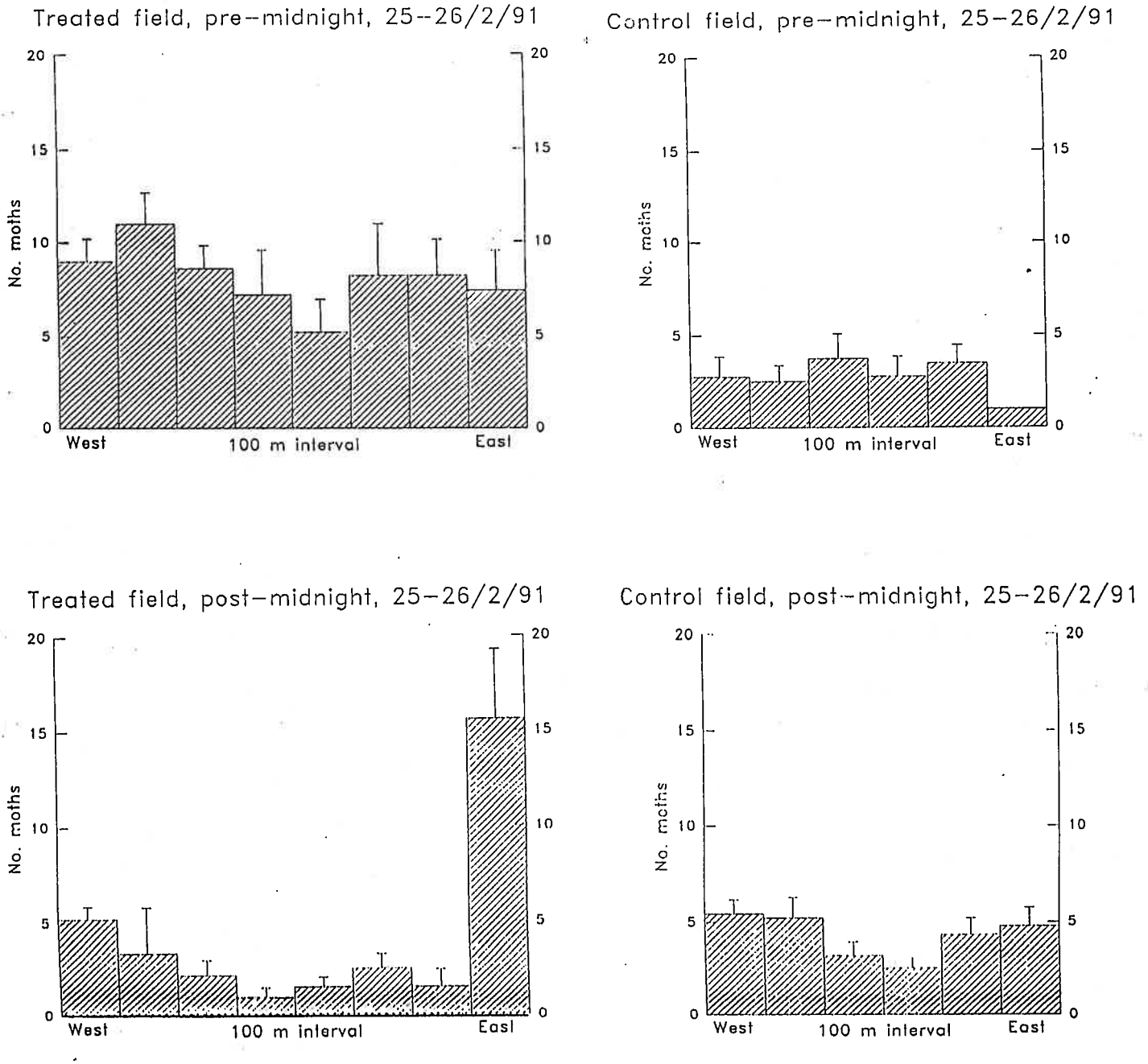

Figure 6. Moths seen with night vision glasses in the treated and control fields, before and after midnight, on 25-26 February 1991.

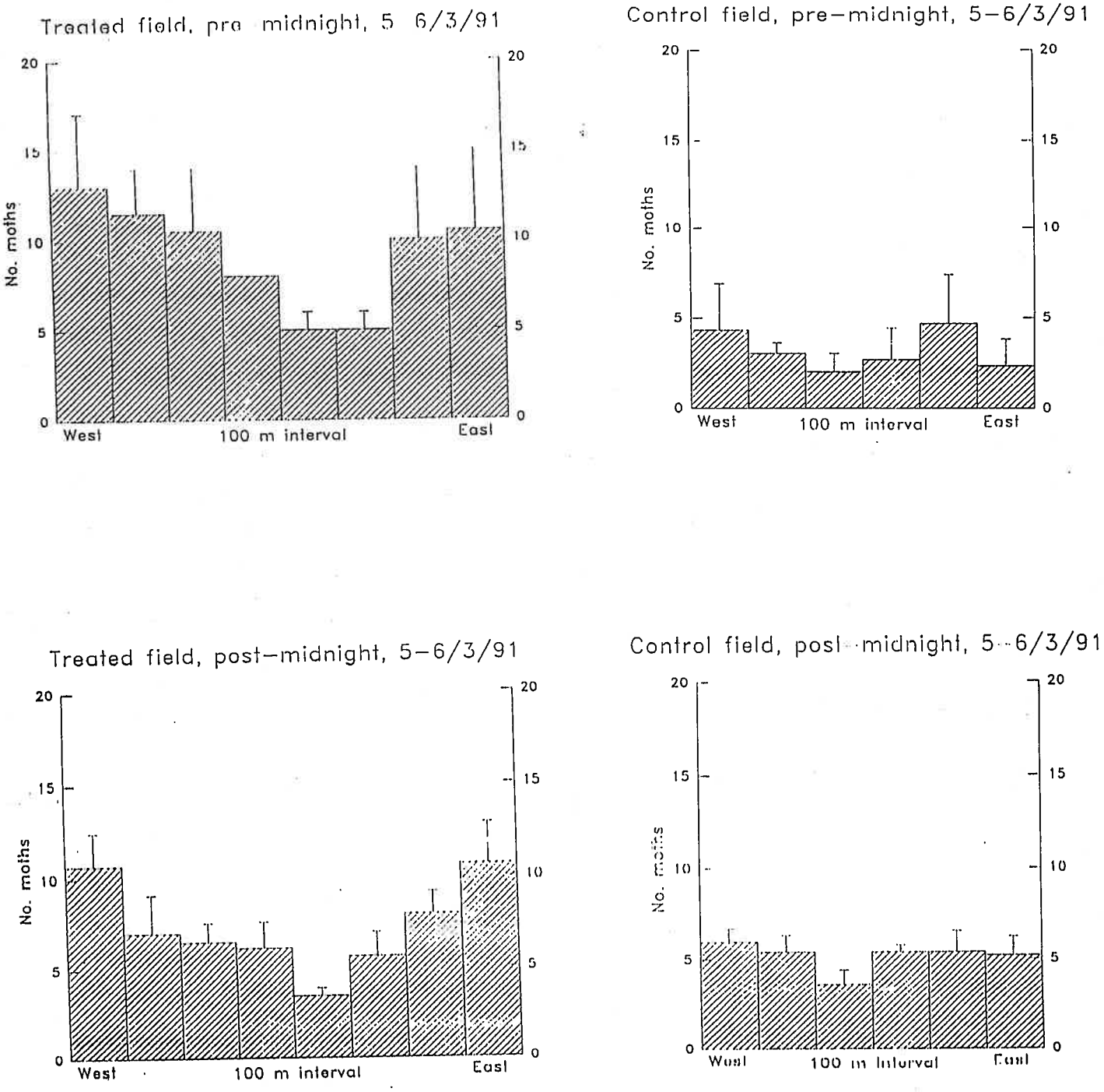

Figure 7. Moths seen with night vision glasses in the treated and control fields, before and after midnight, on 5-6 March 1991.