

## FACTORS INFLUENCING EGG SURVIVAL AND LARVAL ESTABLISHMENT OF *HELIOTHIS* ON COTTON.

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Mortality of *Heliothis* eggs can be due to a number of factors and is highly variable, especially early in the season. An improved understanding of the level of egg mortality and the factors responsible for it, will provide considerable benefit in assessing the need for insecticide sprays. A possible reduction in early season pesticide application would be advantageous, as these sprays can disrupt the establishment of natural enemies of both *Heliothis* and mites. During the 1991/92 cotton season, research was commenced to quantify the mortality of *Heliothis* eggs and to investigate the factors responsible (both biological and non-biological). With this background information, it is hoped to develop methods for predicting egg mortality throughout the growing season.

### Methods

All observations were carried out in unsprayed cotton, so that natural levels of mortality could be observed without the complicating effects of mortality due to pesticides. Several different cotton varieties were used in the study, with the majority of the work being centered on Siokra, Sicala and N74-720-199B (referred to as N74), an okra glabrous variety.

#### a) Fate of marked eggs:

Selected eggs were marked by drawing a ring around the egg on a leaf using a waterproof marking pen. Their condition was observed and recorded on a daily basis. If eggs hatched, the presence or absence of new larvae was noted. As a result of these observations, the fate of each egg was decided as belonging to one of five categories:

1. Disappearance: with no trace of egg remaining. This category includes several factors such as; dislodgement due to wind or rain action, or the plant brushing against other plants. Egg loss due to loss of plant parts, such as leaf or square shedding, is also included within this category. Another possible factor within this category is predation that leaves no remains, where eggs are carried away or completely consumed. This sort of predation may be exhibited by

spiders, ants and some beetle species. The red and blue pollen beetle, *Dicranolaius bellulus* was plentiful early in the season and were shown to eat *Heliothis* eggs in the lab. However, in the field situation, where other food is available, it is not yet known if these beetles play an important predatory role.

2. The second category of predation includes only predation that left distinct egg remains, such as that caused by assassin bugs and mirids. These sucking insects leave eggs that are puckered and empty and are thus fairly distinctive.

3. Infertile/dead eggs: these were eggs that were still present on the plant after 6 days but were either undeveloped, still white or cream in colour, or development had stopped, i.e. they remained brown while other eggs of the same age continued on to hatch.

4. Eggs were listed as suspected hatched when egg remains indicating a successful hatching were found OR a newly hatched larva was found very close to where the marked egg had been. The remains of an egg left after a larva has hatched and partly consumed the egg shell are generally consistent. Usually a small amount of egg shell remains attached to the leaf after the larva has hatched, mostly as a flat disk of shiny egg material but sometimes only half the egg shell may be consumed. If the egg has been dislodged or fallen off the leaf, then no signs of attachment remain.

5. The final category is for those eggs which were deemed to have hatched. To qualify for this category, there had to be egg remains present AND a newly hatched larva had to be found very close to the area where the egg was marked.

#### **b) Protection treatments:**

In order to identify possible factors influencing egg mortality, different protection treatments were applied to the marked eggs:

1. Some eggs were left unprotected: These eggs were exposed to all natural elements and predators.

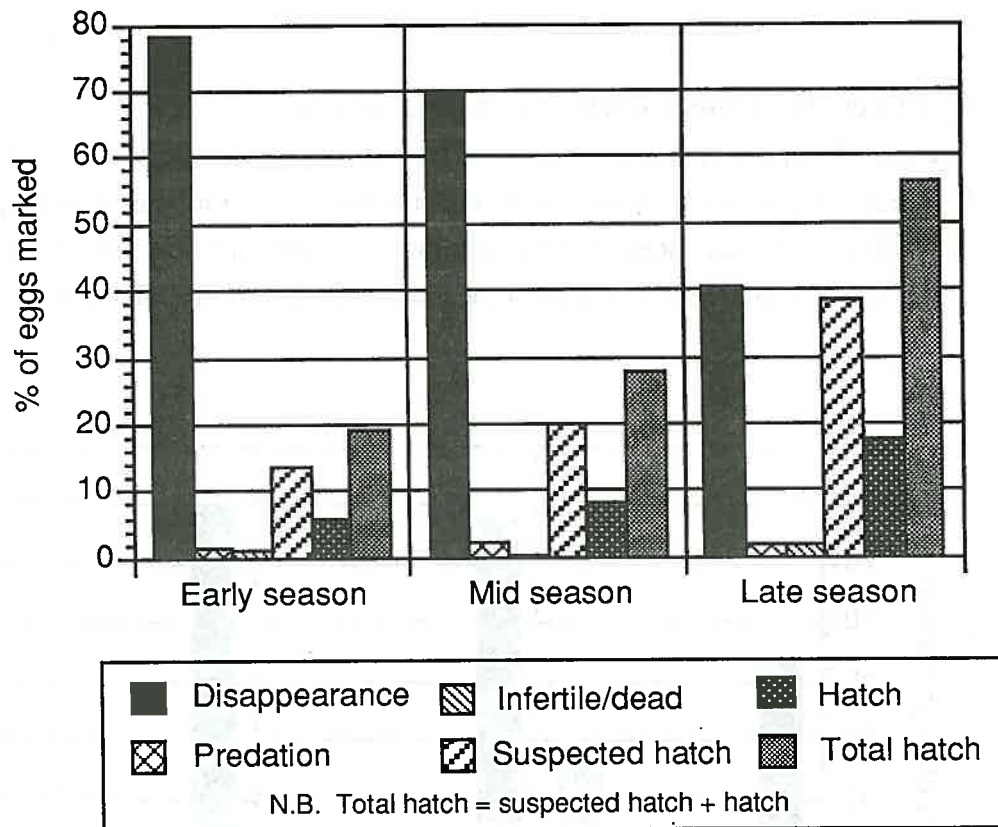
2. Open cages: Plants were enclosed within nylon cages consisting of four walls only, without lids. These cages gave some protection from wind buffeting and plant brushing, but eggs were still exposed to predators.

3. Closed cages: Plants were fully enclosed within nylon cages with lids present. These cages were sprayed to kill any predators present and moths were then released into the cages to lay eggs in a predator free environment. These cages also offered protection from wind buffeting, plant brushing and direct rain impact.

## Results and Discussion.

### a) Changes in egg mortality throughout the season:

In order to gain some understanding of the changes in egg mortality throughout the season, results from unprotected eggs were divided into either early season (November), mid season (December to early January) or late season (late January onwards) results. This data, summarised in Figure 1, relates only to unprotected eggs, exposed to all natural conditions.



**Figure 1:** Fate of unprotected eggs throughout the growing season.

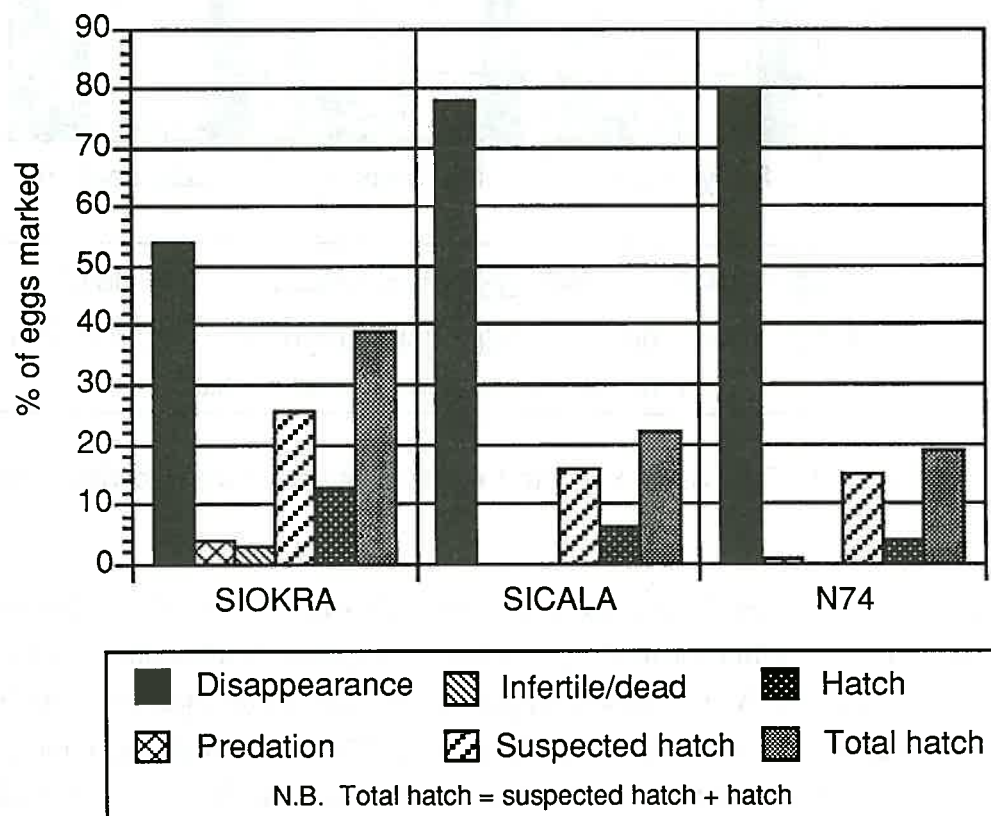
Early in the season, losses were relatively high, with 78% of all the observed eggs disappearing. While the total hatch, which is suspected hatches plus actual hatches, was only 19%. As the season progressed, the rate of disappearance declined to 69% mid season and 40% late in the season. The total hatching rate increased to 28% mid season and 56% towards the end of the season. The rate of infertility and predation remained fairly constant throughout.

These results indicate that as the plants grow larger, they offer more favourable conditions for survival of eggs. The increasing cover of the plant canopy improves the micro climate for egg development by offering protection from harsh climatic effects such as direct exposure to high temperatures and drying winds.

As part of this work, temperature and humidity data were recorded from various points in the plant canopy. When fully analysed, this data will help correlate egg losses to specific climatic conditions. So in the future it may be possible to predict, for example, what effect a period of hot dry weather will have on the hatching success of a particular egg lay.

#### b) Effect of cotton variety on success of eggs:

The fate of unprotected eggs was plotted for each variety separately, as shown in Figure 2. This figure includes results taken across the whole season. Comparison of the three varieties shows that the total possible hatching was greater on Siokra (39%) than on either Sicala (22%) or the okra glabrous variety N74 (19%).

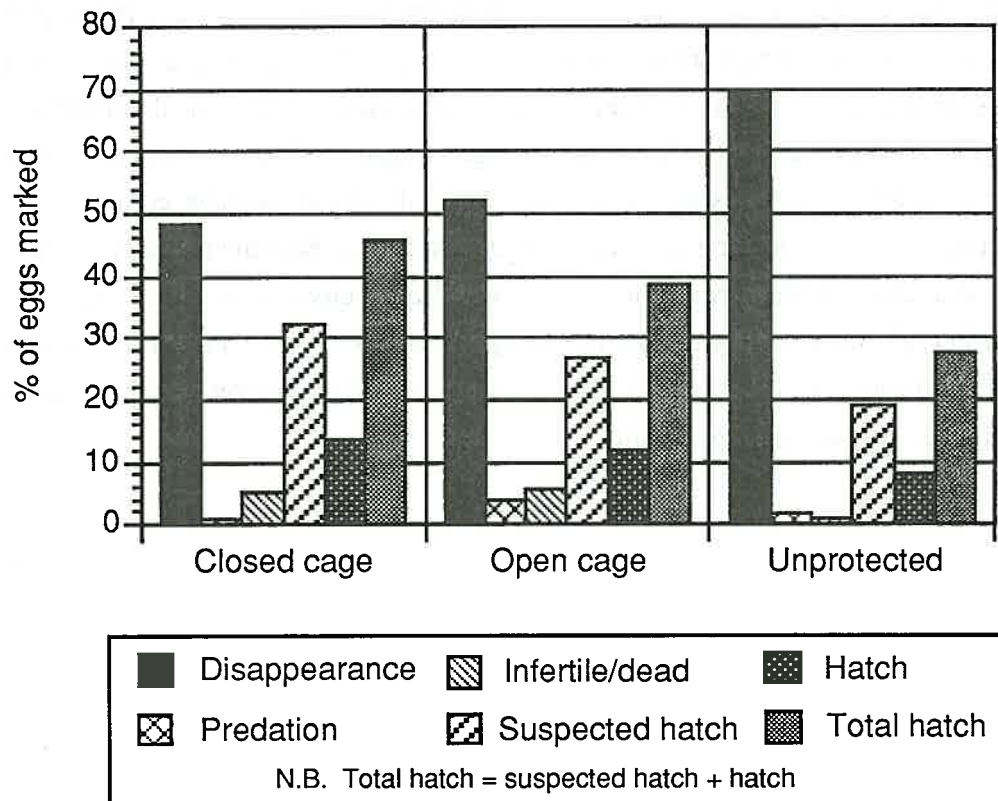


**Figure 2:** Fate of unprotected eggs on different cotton varieties.

It has been suggested that the okra leaf shape allows for greater entanglement of leaves leading to greater levels of dislodgement than that experienced by eggs on normal shaped leaves. This does not appear to apply to the data collected so far. However, the N74 variety also has an okra leaf shape, and the rate of egg disappearance recorded from that variety is practically the same as the normal leaf variety, Sicala. Clearly, more field studies are needed before definite conclusions can be made about the effect of cotton variety on egg mortality.

**c) Effect of protection treatments:**

Manipulation of the various protection treatments allows us to isolate the effects of various biotic and abiotic factors on egg mortality. Differences in egg survival under the different protection regimes is summarised in Figure 3. Data in this figure is for all varieties, combined across the whole season.



**Figure 3:** Fate of eggs subjected to different protection treatments

It can be seen that offering more protection to the eggs increases the percentage of eggs hatching. By looking at which mortality factors have been removed in each protection treatment, we can gain an idea of the relative importance of each of the factors with regard to egg mortality.

The protection offered by an open cage led to a decrease in the number of eggs disappearing, from 70% of unprotected eggs down to 52% for eggs in open cages, a drop of 18%. This suggests that the buffeting effect of wind and the action of plant entanglement may be important factors in *Heliothis* egg mortality.

Differences in egg loss between open and closed cages could be attributed to factors such as predator exclusion and protection from direct rain impact. The measured rate of predation was 4% in open cages. This figure suggests that predation is not an important factor. However we could easily be underestimating the true rate of predation because of an inability to detect predation of whole eggs.

#### **Future work**

The natural mortality of *Heliothis* eggs is high, especially early in the growing season. It would be a great advantage if we could predict the levels of mortality likely to occur within a given egg lay, we would know if chemical control of these eggs is warranted. If a great percentage of eggs will die naturally then costly sprays, which often disrupt the establishment of natural enemies, could be avoided. In order for this predictive model of egg mortality to become a reality, work needs to continue on the correlation of egg mortality to environmental conditions. The effect of cotton variety on egg mortality is also going to be studied in more detail. In addition to this, detailed studies of larval establishment on cotton plants is also planned for the coming season.