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Integrated Pest Management of Cotton in New Mexico: Will Okra Leaf Cotton Reduce *Helicoverpa zea* Populations in Semi Arid Environments with Developing Resistance to Bt Cottons

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Introduction

With resistance to Bt cotton developing in lepidopterous pests it's important to find alternative methods of control. In semi-arid cotton growing areas low relative humidity and high temperatures may have an impact on hatch rates helping to control insect pests, but late season the microclimate of the cotton canopy is more conducive to higher hatch rates and potential yield losses. Use of okra-leaf cotton may help reduce hatch rates by allowing greater air and light penetration into the canopy producing a microclimate less conducive to high egg hatch. (Andres et al 2016 and Mahan et al 2016).

Abstract

Changes in crop microclimate can impact insect populations. Standard upland cotton (*Gossypium hirsutum*) typically has large leaves that provide shade, potentially lowering the canopy temperature and increasing the relative humidity, particularly in semi-arid environments. Lower temperatures and higher relative humidity could allow increased survival of pests, such as, the cotton bollworm, *Helicoverpa zea* (Boddie). Field trials were conducted in New Mexico to determine if okra leaf cotton could help control bollworm populations as resistance to Bt cotton becomes a more widespread issue. Predator populations might also be affected by changes in microclimate.

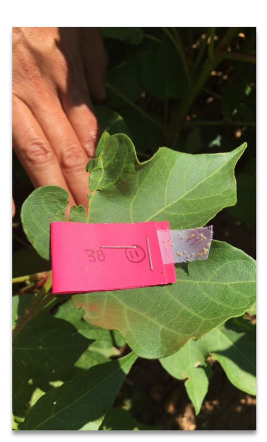
H. zea egg hatch was recorded in an open canopy okra-leaf variety (UA107), and a closed canopy (DP1845B3XF) variety with standard leaves. Clusters of 30-60 bollworm eggs were placed on leaf surfaces at mid-canopy in okra leaf and standard leaf cotton varieties. Egg clusters were retrieved after 48 hours and examined under a microscope to record predation and larval hatch at 48, 72, and 96 hours. Air temperature and relative humidity were recorded with HOBO dataloggers. There was significantly lower egg hatch in okra leaf cotton 31% vs 54% mean hatch in standard cotton in 2020. However, there were no significant differences in relative humidity or temperature to explain lower egg hatch rates. In 2021, this trial was repeated with additional treatments to evaluate the impact of solar radiation that might explain lower hatch rates in okra leaf canopies. Shading had a dramatic impact with 56% hatch with 90% shade vs 25% hatch with no shade.

Materials and Methods

From left to right: normal (standard), sub-okra /sea-island, okra, and super okra (Andres et al, 2016).

Two cotton varieties were planted in 2020 and 2021, the palmately lobed okra leaf cotton (Cotton Cultivar UA107, University of Arkansas) and standard broad leaf cotton (Bollgard® 3- DP1845B3XF, Monsanto Corporation). Experimental plots consisted of 6 rows, 15.2 meters in length with okra leaf treatment replicated 5 times and the standard leaf replicated 4 times (n=9) in a randomized block design.

Sentinel *H. zea* eggs laid on fabric were stapled to leaves mid-canopy and left in plots for 48 hours to access predation and impacts on *H. zea* egg hatch.



Egg masses

H. zea hatch in okra-leaf vs. standard leaf cotton

There was significantly lower egg hatch in standard leaf cotton on, two dates July 13 and August 17, 2020; 19-27% hatch in okra-leaf vs 51-52% in standard leaf cotton.

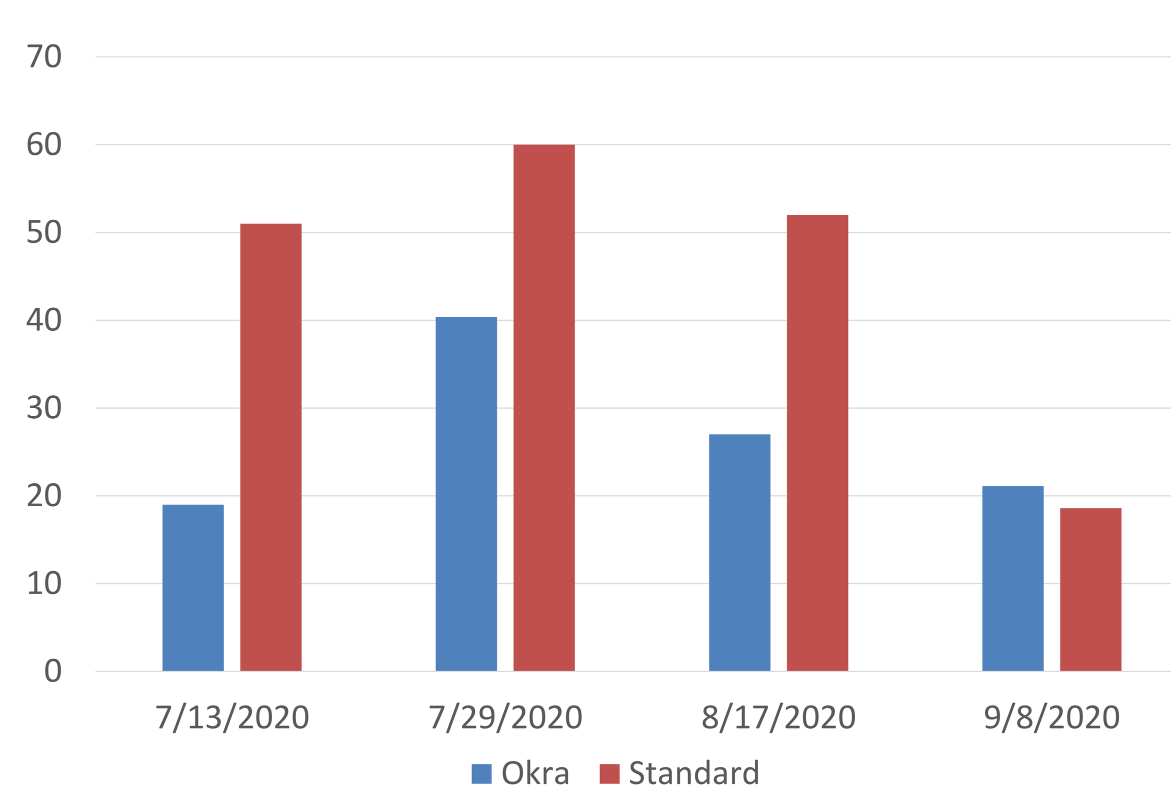


Figure 1: Percent Egg Hatch at 96 hours after 48 Hours in Okra-leaf vs. Standard Cotton Plots.

Temperature and relative humidity in the cotton canopy

Relative humidity was similar in okra-leaf and standard plots. Temperature was significantly higher by 3-4°C in standard leaf vs okra-leaf plots on 2 of 6 dates in 2020; July 20th and July 29th (Table 1).

Table 1. Average Daily High Temperatures and Relative Humidity in Six Microclimate Trials With Okra-Leaf and Standard Leaf Cotton.

	Temperature ° C			Relative humidity (%)		
Date Initiated	Okra-leaf	Standard leaf	Difference	Okra-leaf	Standard leaf	Difference
7/13/2020[1,2]	40	41	1	82	79	-3
7/20/2020[2]	36	39*	3	85	83*	-2
7/29/2020[1,2]	43	47*	4	98	100*	2
8/2/2020[2]	42	45	3	94	97	3
8/12/2020[2]	41	43	2	90	88	-2
8/17/2020[1,2]	38	37	-1	100	100	0
Average	40	42	2.5	91	91	-0.3

Temperature and relative humidity statistically significant between varieties p≤ 0.05.

Okra-leaf plots had significantly lower egg hatch on 7/25-27 in 2021 with 46 vs 60% hatch in standard leaf plots. Hatch rates were much more variable in okra-leaf plots than standard leaf plots (Figure 2). Twice as many egg 'masses' had 0% hatch in okra-leaf plots on 7/25/21 compared to standard leaf plots (Figure 3).

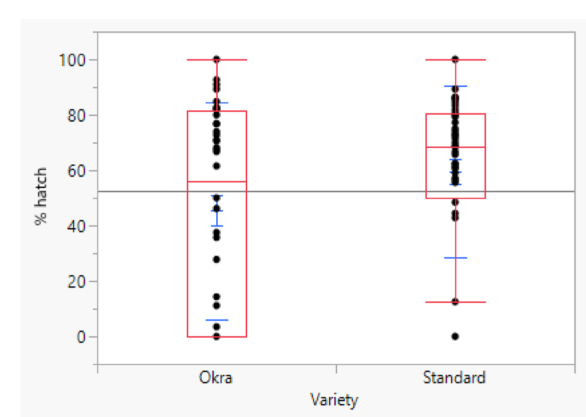


Figure 2: Mean % Hatch of Bollworm Eggs after 48 Hours in Okra-Leaf vs Standard Leaf Plots.

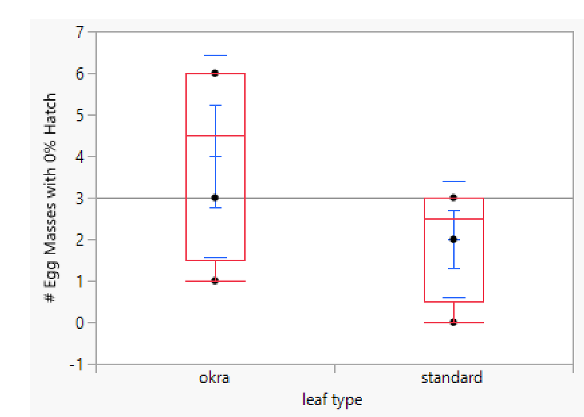


Figure 3: Mean number of eggs with 0% Hatch in Okra-leaf vs Standard leaf cotton plots.

As in 2020, there were no significant differences in temperature and relative humidity in the canopy of okra leaf or standard leaf plots. (Table 2) Mean temperatures during the 7/25/21 field to lab assay were 25-26°C. Relative humidity was 63.8 and 66.6 in okra and standard leaf plots respectively. The ambient relative humidity was significantly lower at 58.7 than in okra or standard leaf canopies.

Table 2. Mean Temperature and Relative Humidity in Standard and Okra-Leaf Cotton Plots 2021

Leaf Type	Mean % RH	Mean Temperature
Standard	66.6a	26.2 a
Okra	63.8ab	25.5 a
None (Ambient)	58.7 b	25.3 a

The shade cloth trial in 2021 demonstrated that more solar radiation produced lower hatch rates. Actual solar radiation in canopy would vary depending on the plant architecture and where eggs were attached relative to orientation to the sun but likely explains part of the lower hatch rates and the greater variation in % hatch in okra leaf cotton plots. Higher solar radiation on some eggs could also explain why there were twice as many egg 'masses' with 0% hatch in okra leaf plots.

In 2020-2021 there were lower hatch rates in okra leaf cotton despite okra-leaf plots not having higher temperature or lower relative humidity. An alternative reason for lower hatch rates in okra cotton could be direct solar radiation on the eggs producing higher temperatures that are not reflected in the canopy temperature. To determine if difference in solar radiation would produce different hatch rates a field trial was conducted in 2021 with shade cloths that reduce light penetration by 30, 60 and 90%.

The degree of shading had a dramatic impact on hatch rates with only 25% hatch in control and 30% shade vs 41 and 56% hatch in 60 and 90% shade treatments respectively (Figure 4).

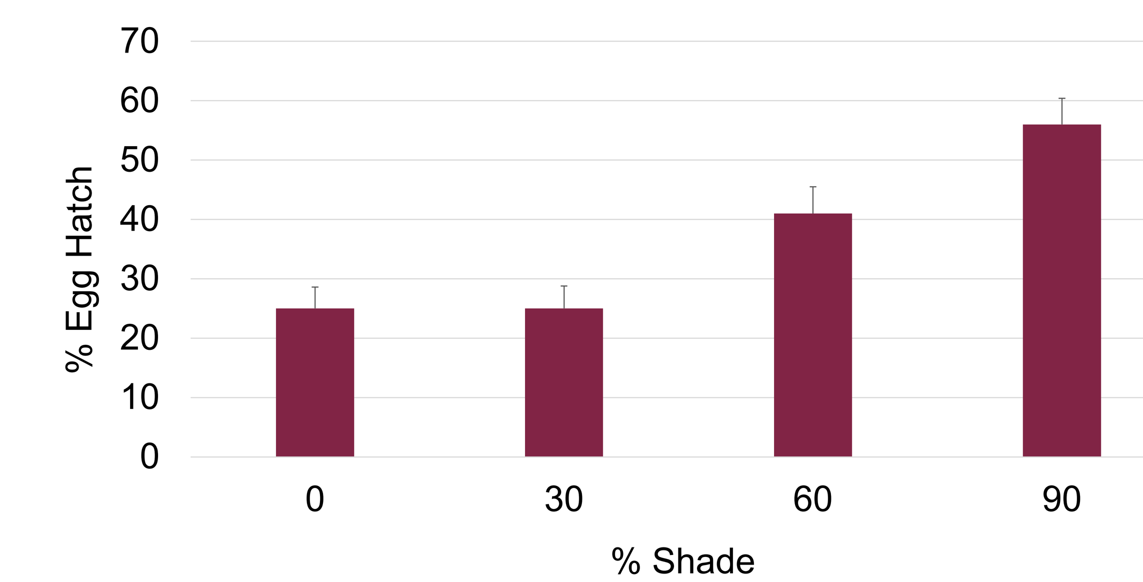


Figure 4: Percent egg hatch of *H. zea* under different shade treatments.

H. zea predation

Egg predation in 2020 was similar in okra-leaf and standard leaf cotton with a mean 41% predation of eggs across seven field to lab bioassays (Table 3). The highest number of egg remains showed evidence of predation by predators with chewing mouthparts, such as adult ladybugs with 22-23% mean chewed eggs season long. There was 12% predation by predators such as ladybug and green lacewing larvae evidenced by hollow eggs with two holes on alternate sides. The lowest predation was by insects with piercing/sucking mouthparts such as nabids which produce collapsed tent shaped egg remains. In 2021, there was again no significant difference in predation between okra-leaf and standard leaf cotton plots.

Table 3. Predation of *H. zea* Eggs After 48 Hours in Field Plots From 7 Field to Lab Assays

	Okra-Leaf (%)	Standard Leaf (%)
Sucked out*	7.2	5.7
Chewed	21.7	22.9
Hollow Eggs	11.7	11.6
Total Predation	41.3	41.2

*Egg Predation statistically significant *P*<=0.05.

Conclusions

Development of cotton varieties with okra type leaves can help suppress lepidopterous pest populations by reducing egg hatch.

Acknowledgements

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