2072 Influence of Management on Crop Microclimate and Control of Cotton Bollworm, *Helicoverpa zea* Boddie

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ABSTRACT

Cotton bollworm*, Helicoverpa. zea* (Boddie) egg hatch under environmental stress was evaluated in laboratory and field trials in southern New Mexico. Constant exposure to 35^{o}C and 17% relative humidity in the laboratory resulted in only 4% egg hatch. Stressed by high temperature, 35^o C ,or low relative humidity, 17%, alone, hatch rates were comparable to eggs held at 26^{o}C and 50% relative humidity. Larvae were held under the same conditions under which they hatched. Larvae maintained at 35^o and 17% relative humidity had only 9% survival resulting in 0.36% survival from egg to pupation. Larvae exposed to one stress 35^{o}C or 17% relative humidity had similar survival to pupation, 29-32% but less than 67% survival at 26^{o}C and 50% RH. The impact of row orientation and row spacing on *H. zea* egg hatch was also evaluated in field trials. Field trials had relatively high hatch rates for a desert environment. Hatch rates in row orientation trials ranged from 37-39%. with only one significant difference in hatch rates in east-west vs. north-south oriented rows in two years. There was also little difference in temperature in rows oriented east-west vs. north-south. However mean high temperature was 3^o C higher in east- west vs. north-south rows when hatch rates were significantly lower in those east-west rows 49 vs. 76% hatch in north south rows. Row spacing trials had no impact on *H. zea* egg hatch. Hatch rates ranged from 43-71% with no significant difference among row spacings, 17, 34, 68 and 96 cm.

KEYWORDS: Bollworm, Cotton, Helicoverpa zea, Insect, Management, Microclimate, Pest

INTRODUCTION

Much of NM cotton is grown in the Chihuahuan desert at an altitude of 975-1128m with conditions that are relatively harsh for many insects. The climate in these desert valleys during the growing season is characterized by high temperatures and low relative humidity during the day and relatively cool nights with higher relative humidity. These high in-season temperatures and low relative humidity are stressful for many insecct pests, and could have some negative impact on hatch rates of lepidopterous pests.

The impact of environmental stress varies among Lepidopteran pests. European corn borer egg masses are very susceptible to environmental stress with, for example, 33^{o}C and 45% RH resulting in only 2% egg hatch compared to 72% hatch at 33^{o}C and 85% RH (Godfrey and Holtze. 1991). Egg hatch was severely decreased regardless of humidity at high temperatures, 36^o and 39^o. European corn borer field egg mortality was strongly correlated with minimum daily relative humidity (Lee 1988). Egg mortality was greater at relative humidities of 35 and 55%, compared to 75% relative humidity. Morrison et. al. (1972) found egg hatch of bluegrass webworm *Parapediasia teterell*a (Zincken) varied with humidity but at least 60% RH produced consistently high egg hatch.

Pink bollworm egg hatch is less affected by low humidity stress. Adkisson (1959) reported pink bollworm *Pectinophora gossypiella* (Saunders) egg hatch was somewhat reduced by low relative humidities (90 and 68% hatch at 75 and 0% RH). This moderate reduction in hatch rates, at very low RH, would not significantly retard pink bollworm populations.

Cotton bollworm, *Helicoverpa zea* (Boddie) is the most consistent insect pest of conventional cotton in New Mexico. Cotton bollworm eggs are typically oviposited on the leaves of cotton plants. This exposed location of the eggs leaves them susceptible to the effects of unfavorable environmental conditions.

Various studies have shown a consistent relation between bollworm population size and temperature (Glick and Graham 1965, Riherd and Wene 1955, Vail et. al. 1968). In New Mexico, the bollworm population will reach its maximum in late July through August. At that point, rainfall is higher and temperatures are more moderate than in June. Also, the plant canopy may moderate the impact of high temperatures and low humidity. Nonetheless, conditions are still likely less favorable for bollworm survival and development than more humid environments.

The temperature range for *H. zea* egg hatch is narrow, 20-27^{o} C, with no egg hatch at 32.2^{o}C (Ellington and El-Sokkari 1986). Increasing RH improved the percent hatch over the temperature span of 20-27^{o}C. Higher temperatures and lower relative humidity are common during the growing season in New Mexico. June-August high mean monthly temperatures range from 32.8-34.4^{o}C in southern NM. Mean monthly low RH ranges from 19-32%RH for June-August. Daily means are more extreme, with daily highs often over 38^{o} C and relative humidity lows of 4%.

Management decisions may also impact the crop microclimate affecting insect pests. In the Rolling Plains of Texas, rows oriented north-south had higher boll weevil damage than those oriented east-west (Slosser et. al. 1986). Similarly, in New Mexico, rows oriented north-south had 38% adult emergence from infested squares, compared to only 9% emergence from rows oriented east-west (Pierce et al. 2001). Although temperatures were similar on the soil surface, relative humidity was significantly lower in east-west oriented rows both before, and after, canopy closure.

Recently, there has been interest in planting ultra-narrow, narrow row cotton and skip row cotton. Planting cotton in narrow row spacing may alter the crop canopy and soil surface microclimate, perhaps making it more favorable for survival of insects. In Texas, narrow row spacing increased boll weevil damage (Slosser et. al. 1986). In New Mexico, 17 cm row spacing had higher boll weevil survival than 34 cm row spacing. and 96 cm row spacing had no survival. Daily high temperature on the soil surface was significantly higher by 5-6 degrees in the 96 cm row spacing than the 34 or 17 cm row spacing. The mean low relative humidity was significantly lower at 17% RH compared to 24-25% RH in the 34 and 17 cm row spacing.

The objective of this study was to determine the impact of environmental conditions that are typical in southern New Mexico and to evaluate the impact of management practices on crop microclimate, specifically row orientation and row spacing on temperature and relative humidity and subsequent survival and development of *Helicoverpa zea* Boddie.

MATERIALS AND METHODS

All laboratory and field trials were conducted at the New Mexico State University Agricultural Science Center near Artesia, NM. Five tests were conducted in incubators to examine the effect of relative humidity and temperature on *H. zea* survival and development under controlled conditions. The four treatments were all combinations of 17% or 50% RH and 26^o C or 35^o C. The photoperiod was L: D 16:8. Eggs were collected from a laboratory colony when they were less than 12 hours old. Thirty groups of 30-60 eggs were placed in standard 100mm x 15mm petri dishes, then monitored at least three times per day. The number of larvae that hatched was recorded, as well as the number of eggs that were pink or black indicating the stage of development. Each day one larvae per dish was transferred to be monitored for further development, a total of 90 larvae per treatment. Neonate larvae were transferred into a small cup provided with standard wheatgerm casein diet and maintained under the same temperature and relative humidity under which it hatched. Data were analyzed using SAS JMP (SAS Institute 1998)**.** Specific comparisons of means were tested with least square means or Tukey's multiple comparison test. When appropriate, individual variety or treatment means were compared with t-tests.

Field to lab bioassays were also conducted to evaluate the impact of row orientation and row spacing. Row orientation test plots were 12 rows wide, 30 m long, with 96cm (38") row spacing with the variety Paymaster1244RR. Each treatment was replicated four times, for a total of eight plots alternating row orientation. Row spacing treatments were 17, 34, and 96-cm (7, 14, 28, 38in) with plots 40m long. The variety was Paymaster 1220, an early season, relatively determinate variety. All plots were irrigated as needed, but no assays were conducted when the soil surface was still moist. Plots were seeded in late April/early May on beds with seeding rates adjusted to produce 14 plants/m.

A total of twelve field-lab assays were conducted to evaluate effects on bollworm egg hatch rates with the different row spacings and row orientation. Eggs were collected from lab colonies when they were approximately 14 hours old. In each test group 30-70 eggs were attached to leaves at mid-canopy. Eggs were removed after 48 hours, then maintained in the laboratory at 26^{o}C and 50% RH and checked regularly until hatch. Data was analyzed using JMP (SAS Institute1998) for Tukey's separation of means or t-tests as appropriate.

In all tests, data loggers (Onset Corp, Pocasset**,** MA) were placed in plots in the same location as the eggs, with at least 3 data loggers per location per field.

RESULTS AND DISCUSSION

As with a number of other lepidopterous insects, *H. zea* is very susceptible to environmental stresses common in an arid and semi-arid environments. In the laboratory testing under constant temperature and relative humidity, the most stressful conditions, 35^{o}C and 17% RH, resulted in only 4% egg hatch (Figure 1). However, when stressed by temperature or humidity alone, hatch rates, 37 and 42% were comparable to the 47% hatch under relatively unstressed conditions 26^{o}C and 50% RH. Ideal RH is at least 60% (Ellington and El-Sokkari. 1986).

Although the single environmental stresses had no impact on egg hatch, they did ultimately impact larval survival. Subsequent larvae exposed, in addition to the egg stage, to only the high temperature or low relative humidity had similar survival, 29-32%. (Figure 2). This was approximately half the survival of those reared as eggs and larvae under 26^{o}C and 50% RH, which had 67% survival to pupation. Only 9% of larvae survived when reared under both temperature and RH stress. The impact of the cumulative stress was evident soon after hatch. Over 60% of newly hatched larvae died within two days at 17% RH and 35° C. When hatch rates of 4% and larval survival of 9% are combined, total survival from egg to adult was only 0.36% under the most stressful conditions, 17% RH and 35°C.

In field trials *H. zea* hatch rates were high considering the relatively harsh environmental conditions. Hatch rates in row orientation tests ranged from 37% to 79%. There was only one significant difference in hatch rates in east-west vs. north south oriented rows in eight field-lab bioassays over two years (Table 1). There was also little difference in temperature in rows oriented east-west compared to north-south. The largest difference in temperature was found on the date where there was significantly lower egg hatch in east-west rows. Mean high temperature was 3°C higher in east-west vs. north-south rows.

Unlike boll weevil there was little impact of row orientation on *H. zea* survival. Boll weevil survival in east west rows was only 9% compared to 38% in north-south rows. Undoubtedly, much if not all of this difference was due to the location of infested squares on the soil surface compared to *H.zea* eggs which are in the plant canopy.

Row spacing did not significantly affect bollworm egg hatch. In all lab-field bioassays hatch rate ranged from 43-71% with no significant difference among row spacing treatments on any date. Average hatch rates across all dates ranged from 42-57%. Mean high temperature and mean low relative humidity were not significantly different among row spacings. Once again, *H. zea* hatch rates were relatively high, and the impact of relatively harsh environmental conditions was not evident in the field. In contrast, boll weevil survival in similar tests was significantly higher in narrow row cotton. Boll weevil survival in similar tests was zero in 96 cm rows, compared to 4 and 10% survival in 34 and 17cm rows respectively (Pierce et al 2001).

While the impact of high temperatures and low relative humidity was clear in laboratory testing, the impact in the field was less clear. Hatch rates in the field under what could be considered relatively harsh conditions resulted in hatch rates that are often comparable to laboratory rearing under fair, if not ideal rearing conditions. The length of exposure to high temperature and low humidity needs to be examined. Southern New Mexico valleys are in the Chichuahuan desert experiencing high temperatures and low RH duing the day, but relatively cool nights with higher RH. Exposure to dessicating conditions during the day may be ameliorated by more suitable environment at night.

Only one test among thirteen showed a significant difference in egg hatch which could be affected by a management decision. That there was some impact suggests that there may be times when the environment reduces populations of *H. zea*. or other lepidopterous pests. Also, areas that have higher temperatures and lower RH may have egg hatch more reliably affected on a regular basis. The lack of difference in hatch rates with changes in row orientation or row spacing suggests that, at least in southern New Mexico, control of *H. zea,* at least, should not be a concern in that decision. Boll weevil, on the other hand, was affected by decisions regarding row orientation and row spacing in previous testing and could be considered in areas where it is not eradicated.

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Table. 1. *H. zea* Egg Hatch and Canopy Temperature in Row Orientation Field Trials.

	% *H. zea* Egg Hatch			Mean Temperature (° C)		Mean High Temperature (° C)	
Date	**East-West**	**North-South**	***P*<0.05**	**East-West**	**North-South**	**East-West**	**North-South**
7/20	**71**	**79**	**NS**	**26**	**25**	**36**	**37**
8/9	**49**	**76**	*****	**29**	**29**	**42**	**39**
9/1	**41**	**37**	**NS**	**19**	**19**	**43**	**42**

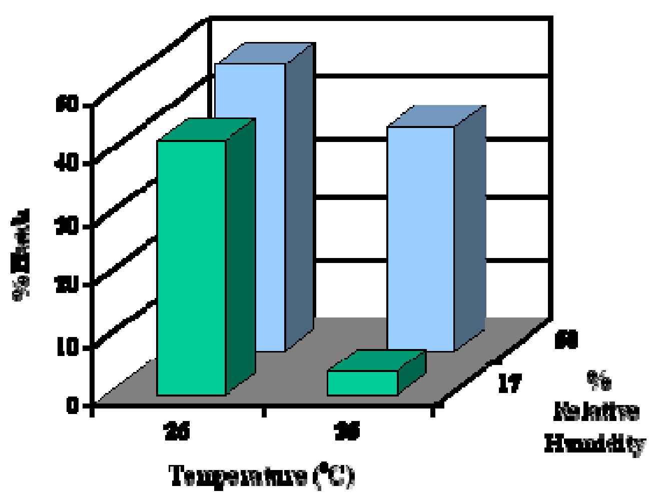

Figure 1. Percent *H. zea* egg hatch after laboratory exposure to a constant temperature and RH

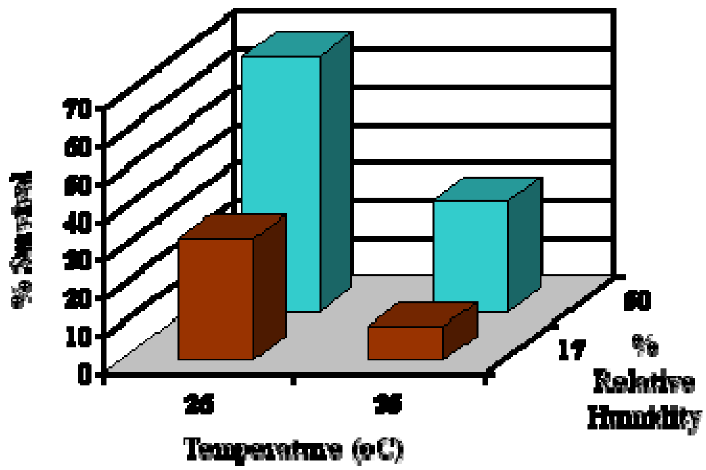

Figure 2. Percent survival of *H. zea* larvae maintained under constant temperature and RH