Development and Fecundity of the Southwestern Corn Borer, *Diatraea grandiosella* Dyar (Pyralidae, Lepidoptera), as Affected by Host Plant Water Stress[1]

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ABSTRACT

Studies were conducted to compare the effect of different plant water stress levels on the southwestern corn borer (SWCB), *Diatraea grandiosella* Dyar. High plant water stress reduced leaf area and plant height but did not affect stem diameter. Host plant water stress had no effect on SWCB larval development time or pupal weight. Adult emergence was 20.0% to 33.0% less in high water stress (35-25% field capacity) treatment when compared with medium (55-45% field capacity) and non-stressed (10-80% field capacity) treatments. Fertility was reduced 7.6% to 16.8% in adults from water-stressed plants.

COMPENDIO

Se comparó el efecto de diversos niveles de escasez de humedad del suelo sobre el barrenador del tallo del maíz, *Diatraea grandiosella* Dyar. Niveles altos de tensión de agua del suelo redujeron el área foliar y la altura de las plantas de maíz, pero no afectaron el diámetro del tallo. La deficiencia de agua en el suelo no tuvo efecto sobre el tiempo de desarrollo larvario o el peso de las pupas. La emergencia de adultos fue de 20.0 a 33.0%más bajo en plantas bajo altos niveles de tensión de agua en el suelo (35-25% de la capacidad de campo) en comparación con plantas bajo condiciones de tensión media (55-45% de la capacidad de campo) y plantas con suficiente humedad (100-80% de capacidad de campo). La fertilidad de las palomillas desarrolladas en plantas con deficiencia de humedad fue reducida 7.6 a 16%.

INTRODUCTION

The southestern corn borer (SWCB), *Diatraea grandiosella* Dyar, described in 1911 from Mexico where it is widely distributed, except in the southern states (11), was reported from New Mexico in the United States in 1913 (8) It is now established in 14 states in the U S corn belt (17) The SWCB mainly infests corn, *Zea mays* L (9) and damage may be caused by larvae feeding in the whorl resulting in "dead heart," tunneling in the stock, and/or stalk girdling (13) Corn losses in the USA have been estimated at about 1% annually (28), but losses in individual fields may reach 100% (24)

Corn is mostly grown under rain-fed conditions and thus water stress may develop periodically and can cause physiological changes in the plant Water stress can reduce plant respiration (3) and photosynthesis (19), which may in turn affect the insects' feeding upon the plants (16). Effect of host plant water stress on insects varies depending upon the host and the insect species. Many studies have been conducted on aphid/host plant water stress. A reduction in aphid reproductive rate on water-stressed brussels sprouts (25) and spindle beet (16) has been reported, but no effect was reported on water-stressed beans (26)

Observations have been reported relative to the effect of host plant water stress only on the SWCB, from the Pyralidae, i e SWCB damage to corn was greater when it received less irrigation as compared to a well-irrigated crop (7) No systematic study has been conducted in this area of host plant/SWCB interaction. Thus, this study was conducted to compare the effect of different plant water stress levels on development, fecundity and fertility of the SWCB. This information may be useful in making management decisions for corn producers in affected areas

MATERIALS AND METHODS

A corn hybrid (Funk G 4507) was grown in the greenhouse using a mixture of peat moss; soil (clay loam); number 2 perlite (ratio 2:1:1) in plastic containers 30.0 cm deep and 28.0 cm in diameter Five lots of 100 g of the mixture were oven-dried at 100°C for 48 h After drying the mixture was wetted and its field capacity was determined as follows:

$$\frac{\text{wet weight} - \text{dry weight}}{\text{wet weight}} \times 100$$

1 Received for publication 17 August 1988

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Treatments consisted of the following:

T_1 (no water stress) = 100-80% field capacity
T_2 (medium water stress) = 55-45% field capacity
T_3 (high water stress) = 35 25% field capacity

Fourteen plants were utilized per treatment in a completely randomized design, treating each plant as an experimental unit and a replication Ten extra plants were grown and maintained as in T_1 These plants were dissected to monitor the insects' development and for measurement of weight gain in test plants during the experiment The study was conducted for two seasons Mean temperature and relative humidity during the experiments were 27.0°C and 70.7% RH in the first and 27 8°C and 43.3% RH in the second season. Studies were conducted in natural light and photoperiod at Texas Tech University, Lubbock, Texas during 1984 and 1985

Containers were watered daily to insure healthy plant growth during the prestress period. Plants were subjected to water stress after 44 days in the first year and 33 days in the second year. Containers were weighed daily on a Universal® Accu-weigh dial scale and water was added when soil reached the required moisture depletion levels Leaf water potential (-MPa) was recorded with a P.M.S.® pressure chamber (20) and leaf temperature, diffusive resistance, and transpiration were recorded using a Li-Cor® LI-1600 steady state porometer (15) at 13:00 to 14:00 h periodically.

After completion of the first stress cycle, a one-day-old SWCB larva was placed on the ear leaf of each plant using a camel hair brush Larvae from laboratory-reared stock were used When pupae were found in extra plants, which were dissected periodically, all test plants were dissected and tunnel length, plant height, leaf area (using Li Cor® leaf area meter), and stem diameter were recorded, and pupae collected Pupae collected from these plants were weighed using a Mettler® unipan electronic balance and maintained in cages (40.0 x 25.0 x 30.0 cm) in a growth chamber at 26.5°C and 65.0% RH Pupae from each treatment were caged together in discrete cages. Adult emergence was recorded from each treatment

Eggs were obtained from wax paper strips taken from the adult emergence cages, counted, and maintained in 3 5 l glass jars in growth chambers. The number of eggs per female was recorded and percent fertility was calculated by counting the larvae eclosed from each treatment Data were analyzed by GLM producedure and Duncan's multiple range test to compare treatments

RESULTS AND DISCUSSION

Effect of water stress on corn

Leaf water potential and diffusive resistance were not significantly different ($P > 0.05$) among the three treatments (Table 1). Water stress levels in the three treatments were based on field capacity and not on leaf water potential When leaf water potential was recorded, plants were at different field capacities because of water application one to three days prior to sampling This water application might have masked the difference in the treatments. Transpiration rate was significantly lower ($P < 0.05$) in the medium and high stress treatments compared to the non-stressed treatment

Leaf area in the non-stressed treatment was significantly greater ($P < 0.05$) than with high stress Plant height was significantly different ($P < 0.05$) between the three treatments in the first year, with height being greatest in non-stressed plants. Only high water stress resulted in a significant reduction ($P < 0.05$)

Table 1. Effect of water stress on corn*.

Year	Treatment	Leaf water potential (−MPa)	Diffusive resistance ($s\ cm^{-1}$)	Transpiration ($\mu g\ cm^{-2}\ s^{-1}$)	Leaf area (cm^2)	Plant height (cm)	Stem diameter (cm)
1st	No stress	1.45 a	9.11 a	6.76 a	5 799.5 a	298.3 a	1.8 a
	Medium stress	1.52 a	12.85 a	4.97 b	5 405.2 ab	243.8 b	1.8 a
	High stress	1.51 a	13.51 a	3.84 b	5 110.4 b	239.2 b	1.7 a
2nd	No stress	1.23 a	6.50 a	4.80 a	3 102.4 a	134.4 a	1.4 a
	Medium stress	1.36 a	15.00 a	3.40 b	2 721.4 ab	122.3 a	1.3 a
	High stress	1.30 a	12.10 a	3.50 b	2 505.3 b	102.8 b	1.5 a

* Means in same column for each year followed by the same letter are not significantly different ($P > 0.05$) using Duncan's Multiple Range Test

in plant height in the second year. Water stress had no significant effect on stem diameter. Reduction in leaf area (1, 5, 10) and plant height (10, 22) in corn as a result of water stress has also been reported by other workers.

Effect of host plant water stress on SWCB

Developmental time of SWCB from first instar to pupal stage was 414 thermal units in the first year and 478 in the second year (mean = 446) when calculated using the equation developed by Whitworth and Poston (27). Thus, the experiments were terminated when the majority of the SWCBs were in the pupal stage in all treatments. Although a few larvae were still present, all pupated within two days. These observations indicate that host plant water stress does not seem to affect SWCB developmental time.

Tunnel length measurements (Table 2) were recorded for the second year only and no significant difference ($P > 0.05$) was found between treatments. Apparently, the amount of larval feeding was not influenced by host plant water stress. Pupal weight in all three treatments was not significantly different ($P > 0.05$) for both years. This also suggests that the food consumed and utilized by larvae was unaffected by host plant water stress. Although pupal weight was not significantly different among the three treatments, adult emergence in the high stress treatment was 20% to 33% less when compared with medium and non-stressed treatments.

Data for adult emergence, fecundity, and fertility could not be analyzed statistically because pupae from each treatment were maintained in the same cage. No clear trend was noted in fecundity (eggs/female) in relation to host plant water stress. Fertility (% eclosion) was 13.0% and 16.8% less in the first year, and 10.8% and 7.6% in the second year in medium and high stress treatments, respectively.

Plant water stress in corn may cause reversible (2, 4, 18, 21) or irreversible (14) changes in protein, nitrogen, proline, and certain enzymes depending upon the degree and duration of the stress. Water stress may reduce protein synthesis (23) and it has been reported that protein contents may be reduced by 9.0% in water-stressed corn plants (12). The lower protein may be responsible for lower SWCB fertility. Changes in certain nutrients affect SWCB females more adversely than males (6) and the complex changes in the corn plant as a result of water stress might also be responsible for lower fertility.

Based on the present results, it can be expected that SWCB infestation following a dry season might be lower because adult emergence and eclosion will be reduced in drought-affected corn.

Table 2. Effect of host plant water stress on southwestern corn borer*.

Year	Treatment	Tunnel length (cm)	Pupal weight (g)	Adult emergence (%)	Fecundity[1]	Fertility[2]
1st	No stress	–	0.25 a	83.3	168	43.5
	Medium stress	–	0.25 a	80.0	253	30.5
	High stress	–	0.23 a	50.0	193	26.7
2nd	No stress	13.5 a	0.22 a	87.5	283	40.3
	Medium stress	12.1 a	0.20 a	86.6	240	29.5
	High stress	14.0 a	0.18 a	66.6	305	32.7

* Means in same column for each year followed by the same letter are not significantly different ($P > 0.05$) using Duncan's Multiple Range Test.

1 Mean number of eggs oviposited per female.

2 Mean percent eclosion.

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