EFFECT OF TEMPERATURE ON DEVELOPMENT AND REPRODUCTION OF *GLOBODERA SOLANACEARUM*

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Accepted:
2.VII.1982
Aceptado:

ABSTRACT

Adams, H.S., W.W. Osborne, and A.J. Webber, Jr. 1982. Effect of temperature on development and reproduction of *Globodera solanacearum*. Nematropica 12:305-311.

The rate of development, size of cysts, and number of eggs and larvae in cysts of *Globodera solanacearum* varied with different soil temperatures. The life cycle was completed in 33 days at 27 C, 38 days at 32 C, 43 days at 21 C, and more than 48 days at 15 C. Cyst size and number of eggs and larvae therein were greatest at 27 C. Both cyst size and numbers of eggs and larvae decreased at temperatures above and below 27 C, but reduction in number of eggs and larvae per cyst greatly exceeded reduction in cyst size at 15 and 32 C.

Additional key words: life cycle, fecundity, reproductive potential, tobacco.

RESUMEN

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La velocidad de desarrollo, el tamaño de los quistes, y el número de huevos y el de larvas en quistes de *Globodera solanacearum* variaron según la temperatura. El ciclo de vida se completó en 33 días a 27C, 38 días a 32C, 43 días a 21C y en más de 48 días a 15C. El tamaño de los quistes y el número de huevos y el de larvas en los mismos fueron máximos con 27C. Las dimensiones de los quistes así como los números de huevos y larvas disminuyeron con temperaturas menores y superiores a 27C, pero la disminución en el número de huevos y en el de larvas por quiste fué mucho mayor que la disminución en el tamaño de los quistes con 15 y 32C.

Palabras claves adicionales: ciclo de vida, fecundidad, potencial de reproducción, tabaco.

INTRODUCTION

The Osborne's cyst nematode (OCN) was first found on tobacco (*Nicotiana tabacum* L., cv. "Hicks") in Amelia County Virginia in 1961 (14). Subsequently, this nematode has been found parasitizing tobacco only in Virginia and causing extensive damage in Nottoway, Dinwiddie, Chesterfield, Brunswick, Lunenburg, Charlotte, Halifax, and Pittsylvania Counties.

This nematode was described by Miller & Gray in 1972 as *Heterodera solanacearum* (12). In 1975, Behrens placed this nematode in the genus *Globodera* (2).

The OCN differs morphologically from other *Globodera* species in characteristics such as cyst shape, color of young cysts, cyst wall pattern between anus and fenestra, and shape of fenestra (12). Hosts of OCN include horsenettle, several commercially grown flue-cured tobacco cultivars, certain varieties of other tobacco types, and some varieties of tomato and eggplant (10, 12, 13). OCN reproduces by cross-fertilization (11) and larval development, and adult sex ratios vary on susceptible and resistant *Nicotiana* species (1). Germ-free tobacco plants (*N. tabacum,* cv. 'NC 35') produced a hatching factor for OCN (8).

OCN is a pest of economic importance on tobacco in Virginia (16), and its control by nematocides in naturally infested areas increased the yield and value of cured tobacco (15). Fresh weight of tobacco increased over controls up to 55% in nematocide evaluation tests (Osborne, unpublished data).

Efficient use of nematocides to control OCN is influenced by the rate of development and reproduction of the nematode. This study was conducted to determine the influence of temperature on rate of development and reproduction of OCN.

MATERIALS AND METHODS

OCN cysts from a naturally infested field in Amelia County, Virginia were used to establish greenhouse populations on tobacco (*N. tabacum,* cv. 'Virginia-115'). Cysts, recovered by washing infested soil through a 60-mesh sieve, were crushed and the eggs were collected on a 400-mesh sieve. Larvae were retrieved from soil by the Baermann funnel technique; these eggs and larvae were used as inoculum.

Tobacco seedlings (*N. tabacum,* cv. 'Va.-15') growing in 50-mesh Weblite(R) (expanded shale) were inoculated with 1000 eggs and 900 larvae per plant and maintained at room temperature (22-28 C) for 3 days. The plants were then washed free of Weblite and residual inoculum and individually replanted into 50-mesh Weblite in 6.5 cm clay pots. Pots were placed into damp, coarse sand in 18-cm-deep plastic pans with 9 pots in each of 16 pans. Four replicate pans (36 replicate pots) were incubated at 15 C, 21 C, or 32 C (±1 C) for 48 days in soil temperature tanks. Air temperature ranged from 22-28 C, and an 18-hr photoperiod of 1000-1500 ft-c was provided by Grolux(R) lamps. Plants were uniformly provided nutrient solution as needed to

maintain vigorous growth.

Four pots were removed randomly from each temperature tank at 5-day intervals after transplanting. Roots were washed free of Weblite, stained with acid fuchsin in a mixture of absolute ethanol and glacial acetic acid (1:1, v/v) for 24 hr, and cleared in a saturated solution of chloral hydrate. The duration of the life cycle of OCN at different soil temperatures was determined by selecting five recognizable stages for observation: white females without eggs, white females with eggs, mature (brown) cysts, cysts containing second-stage larvae, and infection of young roots by these larvae. Only the time of initial appearance of each of these stages was determined. Twenty cysts, five per replicate, were selected randomly from replicates at each temperature, the length and width measured, and each individually crushed to determine the numbers of eggs and/or larvae per cyst. Length of cysts was measured without neck, and width was measured at the widest region of the body.

RESULTS

The life cycle of OCN was completed in 33 days at 27 C, 38 days at 32 C, 43 days at 21 C, and more than 48 days at 15 C (Figure 1). Rate of development

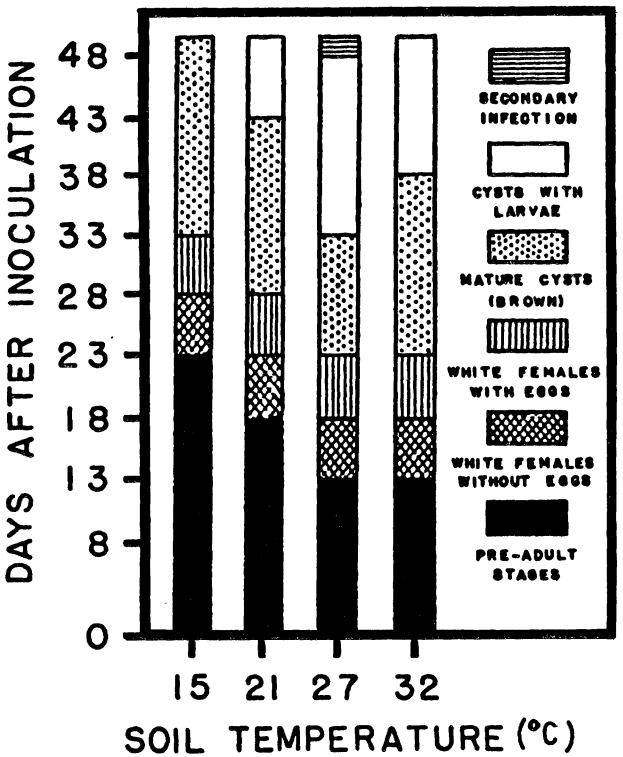

Figure 1. Effect of soil temperature on the development of Osborne's cyst nematode.

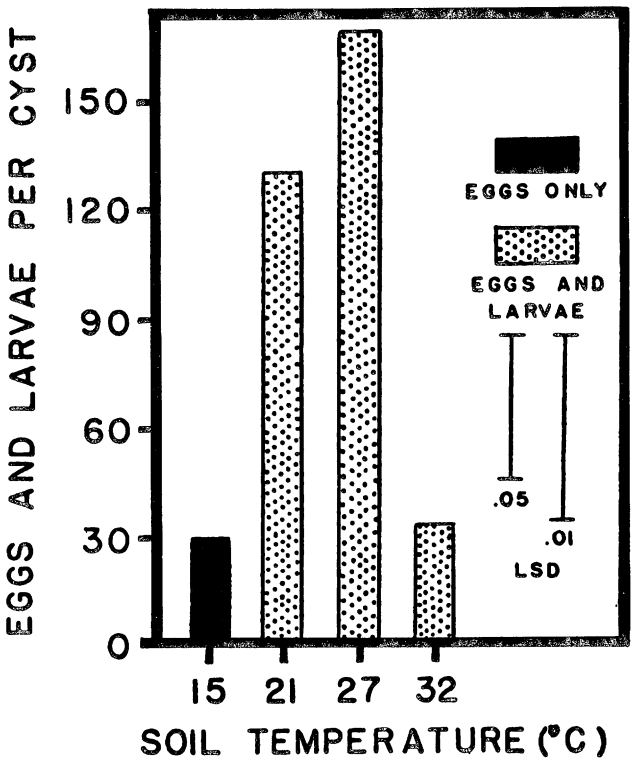

Figure 2. Effect of soil temperature on the number of eggs and larvae per cyst of Osborne's cyst nematode.

up to apperance of cysts was the same at 27 and 32 C, although appearance of second-stage larvae in cysts was retarded at 32 C. Elapsed time from appearance of white females without eggs to white females with eggs and from white females with eggs to brown cysts was the same at all temperatures. Secondary infection of roots was observed only at 27 C, about 15 days after the appearance of the first larvae in brown cysts.

The number of eggs and larvae in cysts was greatest at 27 C but not significantly greater than that at 21 C (Figure 2). At both 27 and 21 C, the number was significantly greater than at 32 or 15 C. Cysts containing second-stage larvae were observed by the 48th day after inoculation at all temperatures except 15 C.

Cysts were largest (length and width) at 27 C and smallest at 32 C (Figure 3). Significant differences in size of cysts were found between those grown at 15 and 27 C, and those grown at 32 C and all other temperatures.

DISCUSSION

Optimum temperature and length of time for completion of the life cycle

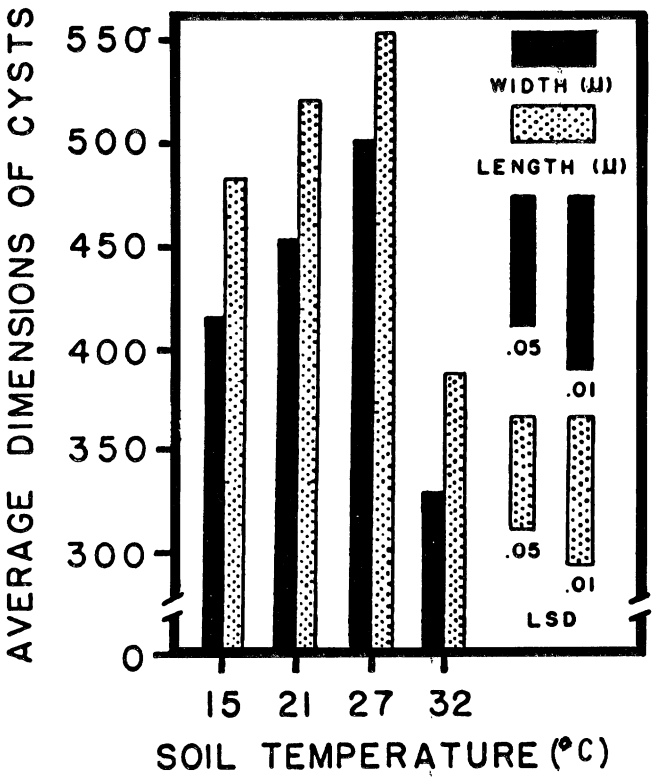

Figure 3. Effect of soil temperature on the average dimensions of cysts of Osborne's cyst nematode.

differ for several *Heterodera* and *Globodera* species (4, 7, 9, 17, 18, 19). The shortest time, 33 days, required by OCN is similar to that reported for *G. rostochiensis* (4) and *H. schachtii* (17), longer than that reported of *H. glycines* (9) and shorter than *H. betulae* (18). Although the time required is similar, the optimum temperature of 27 C for OCN is considerably higher than that reported for *G. rostochiensis* (6) but similar to that of *H. betulae* (18).

Environmental factors such as variety of host (5), clay content of the soil (3), and soil temperature (6) were reported to influence the number of eggs and larvae in cysts of some species. Fenwick (6) reported that the number of larvae from cysts of *G. rostochiensis* was greatest at 15 and 21 C, lower at 27 C, and considerably reduced at 32 C. The size of cysts and number of eggs and larvae in cysts of OCN was also influenced by soil temperature with the greatest size and number per cyst at 27 C. However, the number of eggs decreased disproportionately in relation to the decrease in cyst size. These data confirm an earlier report by Ellenby (5) that smaller cysts contained disproportionately fewer eggs.

The results of this study indicate that temperature affects not only the rate of development and reproduction of *G. solanacearum,* but also the size of cysts and number of eggs and larvae in cysts.

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Received for publication:
19.IV.1982
Recibido para publicar: