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OCCURRENCE OF TARNISHED PLANT BUG POPULATIONS WITH TWO INTENSITIES OF DIAPAUSE IN THE MISSISSIPPI RIVER DELTA

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Abstract

Overwintering tarnished plant bug adults, *Lygus lineolaris* (Palisot de Beauvois), were collected near Stoneville, MS, from henbit, *Lamium amplexicaule* L., or plant debris during December 2003 and January 2004 and dissected to determine their reproductive status. Diapause in adults collected from henbit was broken during December, and most males and females were reproductive by the end of December. Adults collected from plant debris were in a more intense diapause which was broken during January, and most adults were reproductive by the end of January. Previous research showed that in winters when henbit bloomed in December through March new generation adults were produced on henbit by mid-March. In the current study, a cold period from mid-January through mid-February stunted henbit and new generation adults were not produced on henbit until April. This new generation produced in April resulted from adults that overwintered in plant debris along with any surviving adults that overwintered on henbit. These adults utilized henbit that began to regrow and bloom in late-February along with other hosts that bloomed in March and April. Our results again showed that the tarnished plant bug has an overwintering population with two intensities of diapause. This enabled the tarnished plant bug to produce new generation adults in March and April in warm winters in the mid-South. In winters with cold periods that kill or stunt winter hosts, the part of the population that breaks diapause in January is better able to survive and produce new generation adults in April. The tarnished plant bug is well adapted to its winter habitat in the mid-South.

Introduction

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is a serious pest of cotton, *Gossypium hirsutum* L., in the mid-South where it is controlled almost exclusively with insecticides. Because of insecticide resistance (Hollingsworth et al. 1997, Pankey et al. 1996, Snodgrass and Elzen 1995, Snodgrass 1996), alternative control measures for this pest in cotton are needed. The development of alternative control measures requires a thorough knowledge of plant bug biology. A critical part of this biology is diapause which allows plant bugs to overwinter as adults.

Snodgrass (2003) estimated that the critical photoperiod [the point on a response curve when 50% of the insects enter diapause (Tauber et al. 1986)] for tarnished plant bugs at Stoneville, MS was around 12 September. Villavaso and Snodgrass (2004) used dynamic photoperiods simulating civil twilight in environmental chambers to estimate the critical photoperiod as occurring on 14 September. Tarnished plant bugs can be collected as adults from host plants in every month of the year in the mid-South (Snodgrass et al. 1984). In years with mild winters, nymphs can also be collected from hosts in every month, and a few overwintering nymphs can also be found (Snodgrass 2003). In the winter months of December, January, and February, one abundant species of wild host plant, henbit, *Lamium amplexicaule* L., blooms and is utilized by plant bugs as a feeding and reproductive host (Snodgrass 2003). Henbit blooms all winter unless it is killed or stunted by cold weather, and nymphs can be found on henbit in January with new generation adults produced by mid-March. Cold spells can kill or severely stunt henbit and stop blooming which will cause nymphs developing on the plants to die. Stunted henbit plants can begin new growth and blooming when warmer temperatures occur. If regrowth and blooming occurs, new generation adults can be produced on henbit by April. Other wild hosts also bloom in March and early April and can serve as reproductive hosts. Some of the more important hosts include sour dock, *Rumex crispus* L., buttercup, *Ranunculus* spp., daisy fleabane, *Erigeron philadelphicus* L., and butterweed, *Senecio glabellus* Poiret.

In addition to having overwintering adults active on winter hosts, part of the overwintering population can also be collected from plant debris. This was first documented in the mid-South by Cleveland (1982). Snodgrass (2003) found that the overwintering adults collected from winter hosts broke diapause during December in 1999 and 2001, and were nearly all reproductive by the end of December. He also collected adults from plant debris beginning in mid-January 2002 and found that they broke diapause during January and were nearly all reproductive by the end of January. This research indicated that plant bugs in the mid-South overwintered in two different states of diapause. The present study was conducted to better document this occurrence by determining the reproductive status of plant bugs collected from henbit

and plant debris during December 2003 and January 2004.

Materials and Methods

Overwintering adult tarnished plant bugs were collected with a sweep net from henbit or from plant debris at approximately one-week intervals during December 2003 and January 2004. Sampling of winter hosts was continued through April to determine when nymphs and new generation adults were present. A new generation of adults was determined by collection of fifth instar nymphs, because adults are highly mobile. Collections were made in Washington County, MS, on 2, 10, 17, 23, and 31 December 2003; and 12, 22, and 27 January 2004. Adults were collected with a sweep net from plant debris by sweeping dead plant material in areas in which wild hosts had grown during the fall. The main host plants found in these areas were goldenrod, *Solidago altissima* L., and giant ragweed, *Ambrosia trifida* L. The best collection areas had thick clumps of dead grass iwhere the fall hosts had grown. The highest numbers of plant bugs were usually collected from the thickest clumps of grass. Tarnished plant bugs were dissected to determine their reproductive status on the day of collection or on the following day. Failure of the reproductive organs to enlarge, and hypertrophy of the fat body were the criteria used to determine diapause (Lees 1955). Tarnished plant bugs in the process of changing from the diapause state to a reproductive state were frequently found. Such adults had large to moderately sized fat bodies with reproductive organs in different states of maturity. In a female, if the ovaries were expanded with one or more mature eggs (eggs in which the operculum was developed), or enlarged ovaries with developing oocytes, and or it had been recently mated [the genital pouch was greatly enlarged (Strong et al. 1970)], it was considered to be reproductive. In males, it was often difficult to determine whether the testes had begun to enlarge because they were frequently covered by a membrane with a white layer of what appeared to be fat. If white fluid was visible in the accessory glands and seminal vesicle, and the accessory glands had begun to enlarge, a male was considered to be reproductive. Adults were killed in 70% alcohol and dissected in distilled water.

All weather data were obtained from the Stoneville Weather Station, Delta Branch Research and Experiment Station, Stoneville, MS. A summary of weather data for Stoneville, presenting average data for 1964-1993, is found in Boykin et al. (1995), and 30-yr average weather data were taken from this publication.

Results

Adult tarnished plant bugs collected on henbit broke diapause during December with males becoming reproductive much more rapidly than females (Fig. 1). Males went from 62% reproductive on 2 December to 97% reproductive on 31 December. Females did not exceed 50% reproductive until 23 December, but were 88% reproductive by 31 December. Males and females were both 100% reproductive by 22 January. Adults collected from plant debris did not exceed 50% reproductive until 31 December for males and 12 January for females. Males and females from plant debris were 100% reproductive by 27 January.

Fifty percent or more of the reproductive females from henbit had mature eggs during all of December, and over 90% of the reproductive females had mature eggs during January (Fig.2). In contrast, reproductive females from plant debris did not have mature eggs until 31 December, and prior to this date, only one of the females dissected was reproductive. Over 90% of the reproductive females from plant debris had mature eggs by 22 January.

Weather affected when nymphs and new generation adults were found in 2004. Temperatures during December 2003 were near average and winter hosts grew well and were utilized by plant bugs as feeding hosts as they broke diapause. A cold spell occurred beginning in mid January, and during the last 13 days of January the low temperature was 0 °C or less on 11 days (a range of -5 to 0 °C). The cold spell continued into February with low temperatures of 0 or less during 12 of the first 18 days (a range of -4 to 0 °C). This cold period stunted the henbit and blooming ceased. No nymphs were collected during January or February from these winter hosts. The average high temperature in March was 2.9 °C above the 30-yr average and the first nymphs (first instars)were found on 18 March on henbit. Fifth instar nymphs, which indicated the presence of a new generation of adults, were collected on 6 April on daisy fleabane and sour dock.

Discussion

The adult plant bugs collected from henbit broke diapause during December 2003, but were unable to produce an early

new generation by March 2004 because of cold weather during January and February which stunted the henbit. In other years, production of a new generation of adults by mid-March was documented (Snodgrass 2003). The adults active on henbit were in a less intense state of diapause, and could be adults produced near the critical photoperiod in September. In some insects, diapause-inducing day-lengths near the critical photperiod produce weaker (shorter) diapause than day-lengths well below the critical photoperiod (Tauber et al. 1986). The adults found in plant debris which broke diapause in January were in a more intense diapause and could have developed in October and November at shorter photoperiods. For most temperate-zone species with an overwintering diapause such as the tarnished plant bug, no specific diapause-terminating stimulus has been identified (Tauber et al. 1986). In the current study, reproduction by the adults from plant debris was probably favored over adults which were active all winter on henbit, since they had to survive a shorter period of time before suitable wild hosts became available. In winters when wild hosts were not killed or stunted, reproduction by both groups of overwintering plant bugs would be more successful and a new generation of adults would be present from both groups in April.

Results from the current study agree with those found by Snodgrass (2003), and both studies showed that two groups of plant bugs in different intensities of diapause overwinter in the mid-South. The current study added data on how plant bugs found in plant debris maintained diapause during most of December. The current and previous research (Snodgrass 2003) showed that the tarnished plant bug is very well adapted to its environment and can utilize favorable weather and plant growth in the winter to increase its population in the mid-South. It is also well adapted to survive cold winters. Additional studies on diapause intensity will be conducted in future research.

References Cited

Boykin, D. L., R. R. Carle, C. D. Ranney, and R. Shanklin. 1995. Weather data summary for 1964-1993 at Stoneville, Mississippi. Tech. Bull. 201. Mississippi Agr. and For. Expt. Sta., Mississippi State, MS.

Cleveland, T. C. 1982. Hibernation and host plant sequence studies of tarnished plant bugs, *Lygus lineolaris*, in the Mississippi Delta. Environ. Entomol. 11: 1049-1052.

Hollingsworth, R. G., D. C. Steinkraus, and N. P. Tugwell. 1997. Responses of Arkansas populations of tarnished plant bugs (Heteroptera: Miridae) to insecticides, and tolerance differences between nymphs and adults. J. Econ. Entomol. 90: 21-26.

Lees, A. D. 1955. The physiology of diapause in arthropods. Cambridge University Press, Cambridge, United Kingdom.

Pankey, J. H., B. R. Leonard, J. B. Graves, and E. Burris. 1996. Toxicity of acephate, cypermethrin, and oxamyl to tarnished plant bugs in vial bioassays and cage studies on cotton, pp. 882-887. *In* D. J. Herber and D. A. Richter [eds.], Proceedings, Beltwide Cotton Production Research Conference, Nashville, TN. National Cotton Council, Memphis, TN.

Snodgrass, G. L. 1996. Insecticide resistance in field populations of the tarnished plant bug (Heteroptera: Miridae) in cotton in the Mississippi Delta. J. Econ. Entomol. 89: 783-790.

Snodgrass, G. L. 2003. Role of reproductive diapause in the adaption of the tarnished plant bug (Heteroptera: Miridae) to its winter habitat in the Mississippi River Delta. Environ. Entomol. 32: 945-952.

Snodgrass, G. L. and G. W. Elzen. 1995. Insecticide resistance in a tarnished plant bug population in the Mississippi Delta. Southwest. Entomol. 20: 317-323.

Snodgrass, G. L., W. P. Scott, and J. W. Smith. 1984. Host plants and seasonal distribution of the tarnished plant bug (Hemiptera: Miridae) in the delta of Arkansas, Louisiana, and Mississippi. Environ. Entomol. 13: 110-116.

Strong, F. E., J. A. Sheldahl, P. R. Hughes, and E. M. K. Hussein. 1970. Reproductive biology of *Lygus hesperus* Knight. Hilgardia 40: 105-147.

Tauber, M. J., C. A. Tauber, and S. Masaki. 1986. Seasonal adaptations of insects. Oxford University Press, New York.

Villavaso, E. J. and G. L. Snodgrass. 2004. Diapause in tarnished plant bug (Heteroptera: Miridae) reared in dynamic-photoperiod environmental cabinets. J. Agri. Urban Entomol. (In press).

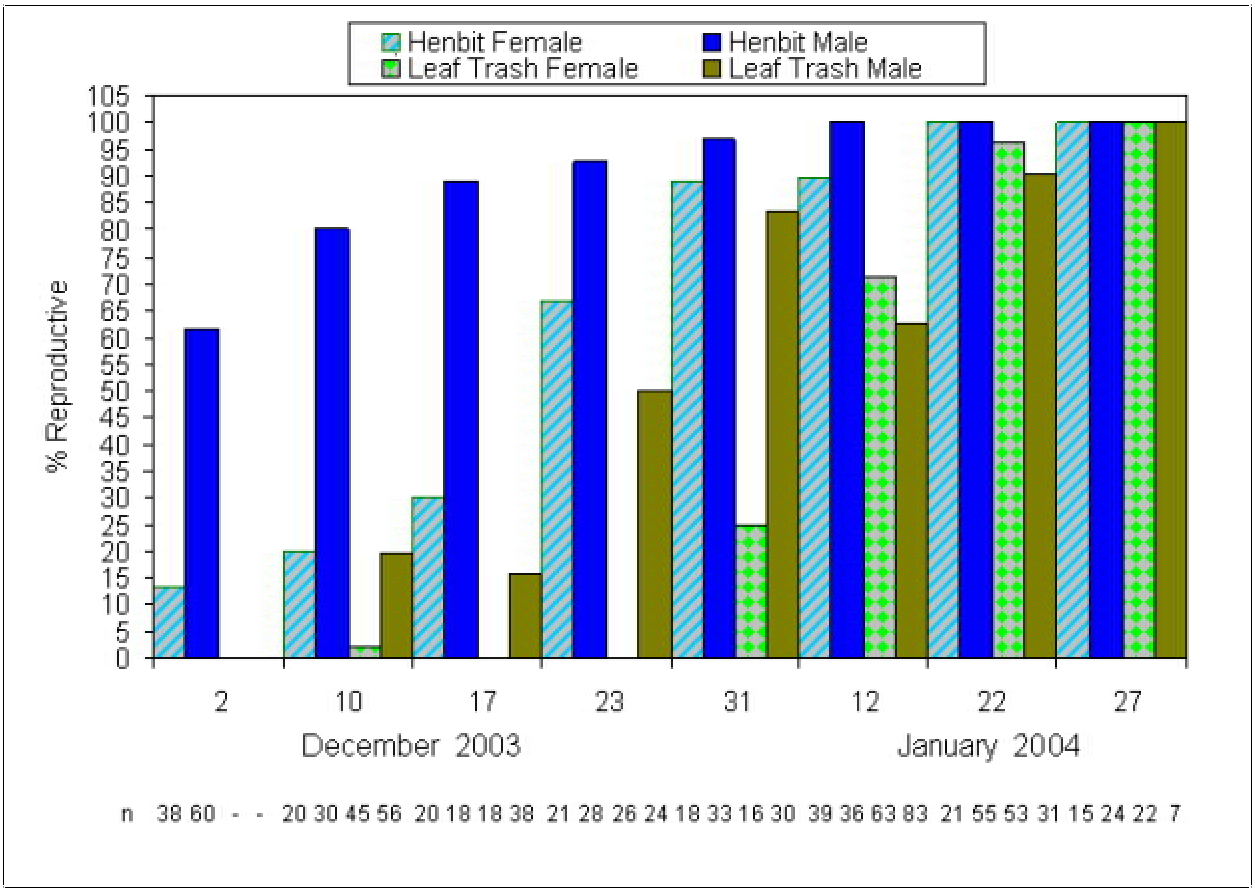

Figure 1. Percentages of overwintering tarnished plant bugs collected from winter hosts or plant debris that were reproductive during December 2003 and January 2004 at Stoneville, MS.

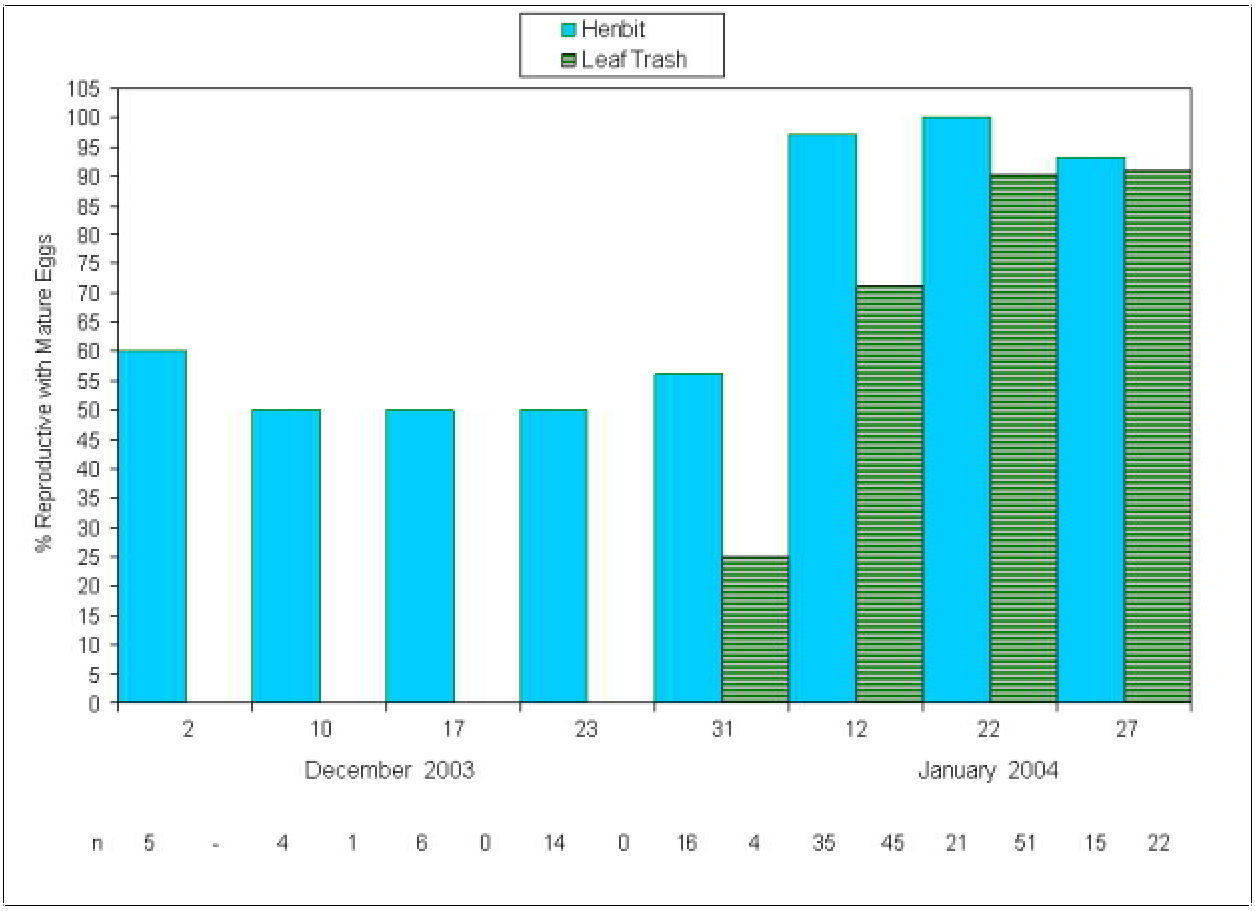

Figure 2. Percentages of reproductive overwintering female tarnished plant bugs from winter hosts or plant debris with mature eggs in December 2003 and January 2004 at Stoneville, MS.