Fat Content and Reproductive Condition of Migrating and Diapausing Boll Weevils in South Carolina and Arizona

J. E. Leggett
USDA-ARS-Western Cotton Research Laboratory
Phoenix, AZ 85040

Abstract

Overwintered female boll weevils, Anthonomus grandis Boheman, collected in grandlure-baited traps were significantly leaner than weevils taken from winter habitat. Weevils that emerged from naturally infested cotton bolls tended to be fat as adults regardless of subsequent adult diet, but adult diet can affect gonadal development. Weevils that emerged from bolls in 1975 in South Carolina had a higher winter survival rate and emerged from winter habitat earlier than the total population. Migrant weevils appear to be mainly colonizers that have some body fat and medium size gonads. The physiological condition of migrants was fairly consistent over time and location in South Carolina but not in Arizona. The time of migratory flight was related mainly to plant maturity and population levels in South Carolina. Weevils collected from cotton plants in South Carolina and Arizona had significantly more body fat than weevils trapped at the cotton field, but oogenesis was variable between the two locations.

Introduction

Migration and diapause are critical events in the life of boll weevils, *Anthonomus grandis* Boheman. Adult boll weevils that emerge from squares or bolls in a cotton field may reproduce at the site, migrate to another field, or enter diapause and leave the field to enter overwintering habitat. According to Dingle (1972) migration in insects is a distinct behavioral and physiological syndrome. Migration may be abetted by responses to photoperiod, crowding, or alteration in the physiology of a food plant. Johnson (1963) concluded that neurophysiological processes cause the characteristic prolonged and undistracted migratory flight, but ecological factors determine when it occurs.

Lloyd et al. (1967) listed five stimuli conducive to diapause induction in the boll weevil: (l) photophase 11 h critical; (2) temperature 10°C critical; (3) adult diet of bolls; (4) limited number of squares; and (5) larval diet of bolls. The relative importance of these stimuli has not been determined; however, several workers have found that plant maturity as indicated by the relative number of squares and bolls, is an important factor in inducing diapause during August and September (Lloyd et al. 1964, Mitchell and Mistric 1965, Sterling 1972, Carter and Phillips 1973). Squares and flowers are predominant on immature plants and bolls predominant on mature plants. Sterling and Adkisson (1974) determined that 10% of the first boll weevil generation entered diapause but by early October, 75% of the emerging weevils entered diapause. Variability in diapause and reproduction among years may be due to the variability in weather and maturity of the cotton plant. Graham et al. (1979) found peaks in diapausing weevils occurring from July through September in Texas.

The purpose of this research was to determine the influence of diet and plant maturity during the growing season on the fat content and reproductive condition of migrant, non-migrant and diapausing boll weevils.

Materials and Methods

General Techniques. Dissections of weevils to estimate fat content and reproductive development from several habitats were made in South Carolina in 1975-76 and Arizona in 1985-87.

Boll weevils were collected from ground leaf litter, cotton plants, and grandlure-baited traps (placed 3.0 m and 4.8 km from cotton fields). The influence of plant phenology, diet and habitat on the weevil fat content and reproductive condition was determined. Females were dissected and the relative amount of body fat, oogenesis and ovariole size was used as an indication of reproductive, or diapausing status. Collected weevils were grouped according to larval and adult diet, site of collection and time of year.
Basically, the diapause characteristics of Brazzel and Newsom (1959) were used to classify the weevils. Body fat was categorized as follows: (l) lean - no fat bodies visible when abdominal integument was removed; (2) some body fat - a few fat bodies near anterior of abdomen; (3) intermediate - fat bodies scattered over abdomen with internal organs partially obscured; and (4) fat - internal organs obscured with fat bodies. Oogenesis was divided into three categories: (l) none - no sign of oogenesis in ovarioles; (2) immature - immature eggs in ovarioles; and (3) mature - mature eggs in common oviduct.

The influence of diet on diapause and reproductive status was determined by feeding the weevils for a period of 1 week on squares or bolls. Weevils were held on the squares or bolls enclosed in plastic cages, (3.2-cm^3, and 5-cm^3, respectively), on the plants and moved to a fresh fruit three times during the feeding period. Cages had 16-mesh screen wire on two sides.

South Carolina. The overwintered weevils collected from leaf litter were dissected for fat and oocyte development but not fed. A sample of overwintered weevils caught in grandlure-baited traps was dissected before and after feeding on squares on the cotton plant. The F_1 and current-season weevils were obtained by collecting infested squares or bolls from the cotton field and placing them in pyramid cages. A sample of the emerged weevils was fed squares or bolls each week, to determine the influence of diet on the boll weevils' fat content and reproductive condition. When bolls became available, ten females were placed on a medium (7 ± 2 day-old) boll on the plant and fed for 7 days.

The remainder of the emerging 1-to 2-day-old weevils were sprayed with paint and released in the cotton field to determine the time and direction of flight from the field and the percent overwintering survival from each cohort. The weevils were evenly distributed on a 0.6 m^2 piece of 16 mesh fiberglass screen and sprayed in the field with paint from an aerosol can, then released on cotton plants. These weevils are referred to as marked migrants when captured in traps away from the cotton field. Grandlure-baited traps were placed along the border of a 1-ha, isolated cotton field (five traps) and 4.8 to 8.0-km away from the field to capture migrating weevils in 1975 and 1976. In 1975, 15 locations had five traps and in 1976, 25 locations had four traps.

Arizona. Boll weevils were collected in Arizona in the fall of 1985 and during 1986-87, to compare their fat content and reproductive condition when collected from different habitats. Weevils were collected in grandlure-baited traps placed at the edge of, or at some distance from cotton. Collections also were made from squares and bolls before defoliation and on regrowth squares at the top or base of the plant several weeks after defoliation.

Results and Discussion

The findings of this study of migration and diapause indicate that boll weevils collected from ground leaf litter in South Carolina exhibited the highest degree of diapause with little variation among individuals; whereas all other collections exhibited a greater degree of variability. The type of fruit (square or boll) in which boll weevils develop and their food preference or source has a definite effect on fat body and gonadal development. Some weevils collected in South Carolina from bolls in mid-August 1975 were in a firm diapause condition, which indicates the influence that diet alone can have on weevil diapause when photoperiod and temperature are not conducive to diapause.

The adults that emerge from bolls are heavier than weevils emerging from squares and are prone to be fat whether they feed on squares or bolls. Weevils that emerge from bolls may be confused with diapausing weevils if they are dissected before feeding or after a limited amount of feeding, since some individuals may have intermediate fat and small ovarioles. The boll weevils that emerge from bolls are likely to be fat and reproductive after feeding on squares, whereas those that feed on bolls will be fat with small gonads. The winter survival of weevils that emerged from bolls in 1975 was much greater than the survival of weevils emerging from squares.

The highest percent of fat weevils trapped in Arizona occurred during the month of October, and oogenesis decreased steadily from September-December (Fig. 1). There was a significant difference in the condition of migrating boll weevils in Arizona and South Carolina. A higher percent of Arizona migrants were classified as fat (Fig. 2). In South Carolina, 80% of the migrant weevils had immature eggs, but in Arizona, only 35% had immature eggs. This difference could be caused by climate, cotton cultivar, or a different strain of weevil. All of the factors which regulate migration are not known, but local crowding as well as a general heavy infestation could trigger some weevils to migrate. The time of peak migration was different between years but it was associated with planting date and plant maturity in this study.

Literature Cited

Brazzel, J. R., and L. D. Newsom. 1959. Diapause in *Anthonomus grandis* Boh. J. Econ. Entomol. 52: 603-611.

Carter, F. L., and J. R. Phillips. 1973. Diapause in the boll weevil, *Anthonomus grandis* Boheman, as related to fruiting activity in the cotton plant. Ark. Acad. Sci. Proc. 27: 16-20.

Dingle, H. 1972. Migration strategies of insects. Science 175: 1327-1335.

Graham, H. M., N. S. Hernandez, Jr., J. R. Llanes, and J. A. Tomayo. 1979. Seasonal incidence of diapause in boll weevil populations in the lower Rio Grande Valley of Texas. Southwest. Entomol. 4: 170-175.

Johnson, C. G. 1963. Physiological factors in insect migration by flight. Nature (London) 198: 423-427.

Lloyd, E. P., M. L. Laster, and M. E. Merkl. 1964. A field study of diapause, diapause control, and population dynamics of the boll weevil. J. Econ. Entomol. 57: 433-436.

Lloyd, E. P., F. C. Tingle, and R. F. Gast. 1967. Environmental stimuli inducing diapause in the boll weevil. J. Econ. Entomol. 60: 99-102.

Mitchell, E. R., and W. J. Mistric, Jr. 1965. Seasonal occurrence of diapause and hibernation of the boll weevil in North Carolina. J. Econ. Entomol. 58: 309-312.

Sterling, W. L. 1972. Photoperiod sensitivity in the ontogeny of the boll weevil. Environ. Entomol. 1: 568-571.

Sterling, W. L., and P. Adkisson. 1974. Seasonal incidence of diapause and reproduction in boll weevils inhabiting the high and rolling plains of Texas. Tex. Agric. Exp. Stn. M.P. 1145: 1-9.

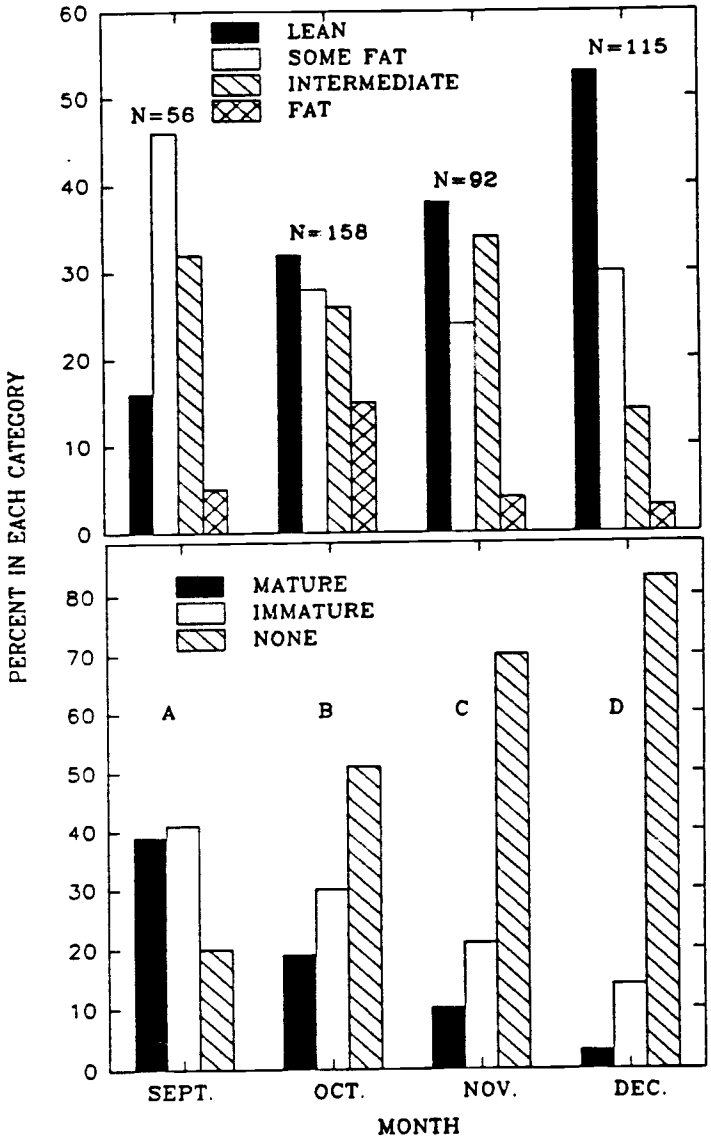

FIG. 1. Body fat and oogenesis of boll weevils collected in traps in Arizona. 1985-86.

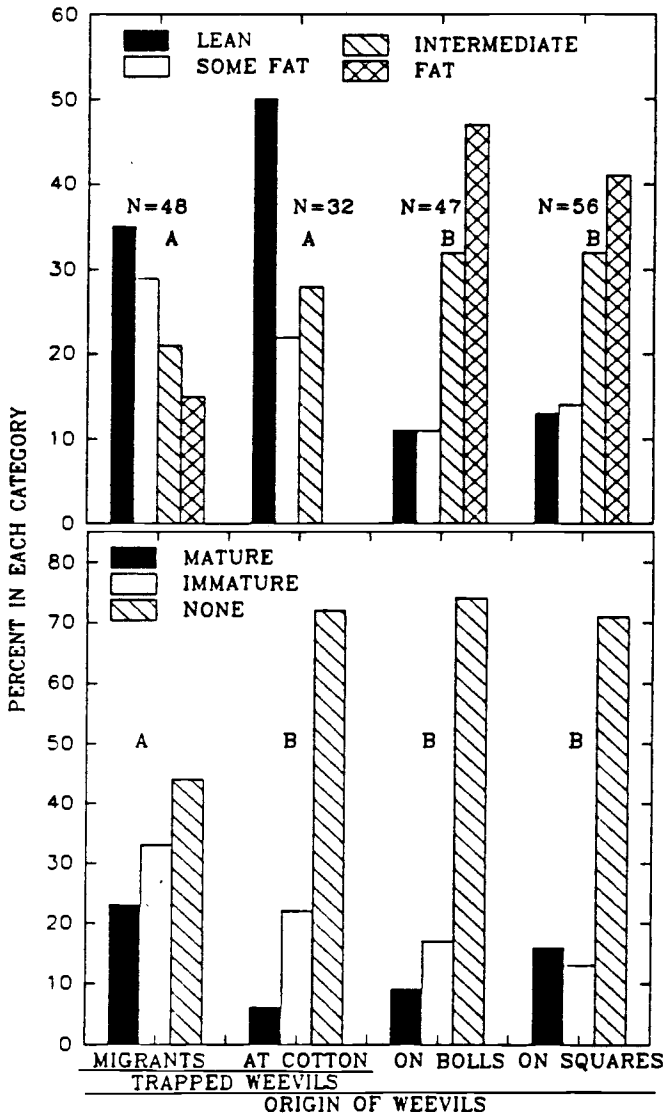

FIG. 2. Body fat and oogenesis of boll weevils collected in traps and from cotton plants in Arizona. October 1985.