EFFECTS OF FALLOW VEGETATION FIELD BORDERS ON ARTHROPODS IN COTTON AND SOYBEAN FIELDS IN EASTERN NORTH CAROLINA

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Abstract

The effects of 5 m wide, managed fallow vegetation field borders on arthropods in cotton and soybean crops were investigated with sweep net sampling, visual inspections and pitfall traps. Field borders enhanced the populations of some beneficial insects in both cotton and soybeans. Thrips were more abundant in cotton fields with borders. Bollworm damage, number of bollworm eggs and larvae on terminals in cotton were similar for both border treatments. Bean leaf beetles in soybeans were more numerous in fields without borders in 1999. Field border presence did not increase the abundance of any pest species in soybeans in 1999.

Introduction

Integrated pest management (IPM) is supported by the general public due to its potential to decrease the use of agricultural pesticides. Issues of concern about agricultural pesticides include food quality, pesticide residues in food, pesticide effects on surface water and ground water quality and effects on non-target wildlife and wildlife habitat. Vegetative borders can reduce the off-target movement of agricultural pesticides by intercepting drift (Cuthbertson and Jepson, 1988) and by reducing movement of soil with adsorbed pesticides. Several conservation agencies have recommended the use of vegetative filter strips to reduce nutrient and soil runoff from crop fields. Field border composition can consist of planted perennial grasses/forbs or of managed fallow vegetation. Vegetated borders may promote one aspect of IPM by serving as a source for beneficial insects, thereby promoting biological control in the agroecosystem (Frank, 1997, Neussly and Sterling, 1994 and Lang et al., 1999). Wildlife can benefit from vegetated borders through the creation of an early successional habitat and the arthropod food resources associated with such habitat.

Most research on field borders in North America has involved the relationship of a specific pest or beneficial species to preexisting, unmanaged field borders. The presence of alternative wild host plants in the field borders could be important for several pestiferous species. Tarnished plant bugs are very catholic in their selection of wild hosts. A review of the literature for tarnished plant bug host plants revealed 328 plant species and an additional 57 to genus only (Young, 1986). Extensive research into the relationships between bollworm complex populations and wild host plants has been also been conducted (Snodgrass et al., 1991 and Sudbrink and Grant, 1995). Consequently, field border management has received some attention. Stadelbacher (1982) and Harris and Phillips (1986) have addressed spring mowing of host plants as a population management technique for the bollworm complex. While field borders may contribute to higher numbers of pest species they may also serve as a source or refugia for beneficial species. The conservation of predatory insects is prominent in biological control so predation of pestiferous insects by various entomophagous arthropods has received some attention. The impacts of fertility manipulations in grass and grass-legume combinations on ground beetle (Carabidae) and spider (Aranae) populations in roadside vegetation in Mississippi have been investigated by Snodgrass and Stadelbacher (1989). They found no significant effects from different fertility regimens on these beneficial insects. Bedford and Usher (1994) have noted that field/woodland edges support a greater diversity of ground beetles and spiders than either habitat alone. Roach (1991) has addressed the possible benefits of natural vegetation serving as overwintering sites for beneficial insects.

Even though field borders may prove beneficial or neutral to agriculture, growers may not be willing to implement these borders without knowledge of the associated weed and insect impacts on crop production. We have been investigating the effects of 5 m wide fallow vegetation borders on the insects in cotton and soybean fields in eastern North Carolina for the last three growing seasons. In the system being assessed, the borders are maintained through targeted applications of herbicides to limit encroachment of woody vegetation. Information was gathered on selected beneficial and pestiferous insects in these crops. Results reported here follow those reported by Sorenson and Outward (1999).

Methods and Materials

A large, multi-disciplinary project evaluating the impacts of herbicide maintained, herbaceous field borders on wildlife and water quality is currently under way in three areas in North Carolina and a fourth area in Virginia. In each study area, field borders have been established on whole fields in two separate contiguous blocks of approximately 250 hectares each. Field border treatment areas have had a 5 m, herbaceous border established completely around the field perimeter. The control fields receiving conventional agricultural treatment are farmed up to the ditch-bank or field margin. Borders are maintained through targeted herbicide applications through a low volume, no-drift, wipe-on

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applicator. This device applies systemic herbicide only to emergent woody vegetation (that extending above the desired border canopy height) and greatly reduces or eliminates the need for mowing. Borders were established in these study areas four years ago; broad-leafed perennials, perennial grasses, brambles and woody vines appear to dominate these strips as they mature.

For our study, a total of 10 fields of cotton and 10 fields of soybeans were identified in the Upper Coastal Plain counties of Wilson, Pitt and Edgecombe in North Carolina; five fields of each crop have a 5 m herbaceous vegetation border around the field perimeter. All fields included within the study were tended by the same grower, and agronomic management within each crop was consistent across field border treatments. In 1997 all cotton and soybean fields were planted with conventional tillage. In 1998 and 1999 soybean fields were no-tilled and cotton fields were strip-tilled.

Within each field, two sampling areas were established. Each area was approximately 45 m wide and ran perpendicular to a field border. Sampling was conducted at 1, 10, 20, and 30 m distances from the field edge except where otherwise noted. Multiple sampling techniques were used at each distance in each sampling area.

Cotton Insects

Pestiferous insects of interest in cotton included thrips, aphids, tarnished plant bugs (*Lygus lineolaris*), stink bugs, bollworms, and foliage feeding caterpillars. Beneficial insects of interest included big-eyed bugs (*Geocoris* spp.), minute pirate bugs (*Orius insidiosus*), damsel bugs (*Nabis* spp.), cocinellids, soft flower beetles (*Colops* spp.), cicindelids, staphylinids and lacewings. Other arthropods studied include spiders and spider mites. In 1998 and 1999 only, at crop emergence, thrips populations were assessed by whole plant sampling of 5 seedlings at each distance in each transect. Plants were excised at ground level and placed in jars with soapy water; these samples were washed and the thrips counted later in the lab. Sweep net samples (15 sweeps per sample) were taken weekly, season long, beginning when the plants had four true leaves. Upon reaching reproductive growth stages, weekly examinations of flower buds and fruit damage were conducted (20 fruiting forms per sample), and 20 terminals per sample were examined weekly for bollworm complex eggs, larvae and damage. Where field width was sufficient, distances for visual inspections of terminals were expanded to 40 and 50 m from the field margin in 1999 only. Spider mite incidence and aphid infestation were assessed weekly concurrent with sweep net sampling in all years.

Pitfall traps were placed once during the 1998 and 1999 growing seasons to collect epigeal arthropods. In 1998 traps were placed within the crop field at 10 m and 25 m from the field margin and collected after 3 days. Traps were located between the crop rows in 1998. In 1999, traps were placed 1 m away from the crop into the adjacent field border or field edge and within the crop field at 10 m and 25 m from the field margin. Traps in 1999 were placed within the crop rows and were open for 3 consecutive days. Arthropods targeted in the traps were carabidae, cicindelidae, staphylinidae, orthoptera and araneae. Trap contents for 1999 have not been processed so only pitfall trapping results for 1998 will be reported here.

Insecticide use in the cotton fields was limited to an in-furrow aldicarb application at planting and an aerial application of a pyrethroid in August in response to bollworm pressure.

Soybean Insects

Pestiferous insects of particular interest in soybeans included bean leaf beetle (*Ceratoma trifurcata*), foliage-feeding caterpillars, stink bugs and three-cornered alfalfa hopper (*Spissistilus festinus*). The beneficial insects of interest are the same as those listed above. Spiders and spider mites were also assessed. Sweep net samples were taken weekly, season long. Weekly estimates of spider mite occurrence were also recorded concurrent with all sweep net sampling dates.

Bean leaf beetle defoliation samples were collected on a single date prior to reproductive growth stage in 1999. At distances of 1 m, 10 m, 20 m, and 30 m from the field margin, 5 plants were randomly selected and excised at ground level. The R3 leaf (Fehr et al., 1971) was removed, separated by leaflets and photocopied. The photocopies will be subjected to a computerized image analysis system to determine percent defoliation. However, the samples have not been processed at this time and will not be reported here.

The pitfall trapping procedure is the same as that listed above for cotton insects.

The 1999 growing season marked the completion of this three-year study. This presentation will concentrate on the results from the 1999 growing season. Data were subjected to analysis of variance using PROC GLM in SAS (SAS Institute, 1990) to determine if field borders contribute to differences in abundance of any of the pest species or of beneficial species. We also tested for differences over time, distance from the field edge or border, and for interactions between these factors. Results listed as significant have $P < 0.05$.

Results

Insect numbers were substantially higher in both crops in 1998 than in 1997 and 1999. The average number of arthropods collected in sweep net samples was substantially higher in soybeans than in cotton for all years.

Cotton

Thrips were significantly higher in fields with borders than fields without borders in 1999 only (Fig. 1). Overall thrips numbers were substantially greater in 1999 than 1998. There were no differences in bolls damaged by bollworms, bollworm eggs and larvae on terminals, or terminals damaged by bollworms between fields with borders and fields without borders in 1999.

Tarnished plant bug abundance was similar for fields with each border type in 1999. Significant differences were recorded in 1997 and 1998 with more tarnished plant bugs in fields with borders, however tarnished plant bug numbers were substantially lower in 1999 than previous years. Stink bug numbers were similar across border treatments for all years.

Among those beneficial insects sampled with sweep nets in 1999, only green lacewings showed a significant difference between fields with and without borders with more present in fields with borders (Fig. 2). Spiders, soft flower beetles, big-eyed bugs and minute pirate bugs exhibited significant differences in respect to distances from the field margin. Spider abundance was greatest near the field margin (Fig. 3) while soft flower beetle and minute pirate bug numbers showed an opposite trend. Big-eyed bugs were least abundant at the field margins and 30 m from the field margins. There were significant differences in the date by border interactions for minute pirate bugs (Fig. 4). Minute pirate bugs and lacewings rebounded significantly faster following the insecticide application in fields with borders.

Pitfall trapping results for 1998 revealed no differences in abundance between border types and distances from field margins.

Soybeans

Insect responses to border treatments in soybeans were not as widespread in 1999 compared to the earlier years of the study. No significant differences by border type were observed for spiders, big-eyed bugs, minute pirate bugs, ladybird beetles, lacewings, and spined soldier bugs in sweep net samples. Only damsel bugs showed a significant response with more present in fields without borders (Fig 5).

Pestiferous insects were similarly unaffected by border type in 1999. Bean leaf beetles were significantly more abundant in fields without borders (Fig 6). Green cloverworms were significantly more abundant in fields without borders and also were more abundant at the field margin only (Fig. 7). More economically important pests (tarnished plant bugs and bollworms) were not affected by the presence of field borders. We did not observe any differences in abundance between border types for three-cornered alfalfa hoppers, soybean loopers, and stink bugs.

We observed significant differences in abundance for spiders in pitfall traps in 1998, with spiders responding positively to field borders (Fig. 8). Orthopterans, predominantly gryllidae, were significantly more abundant in fields with borders (Fig. 9). Cicindelids (tiger beetles) were significantly more abundant in fields without borders (Fig. 10).

Discussion

Managed fallow vegetation field borders appeared to enhance the numbers of some important predatory arthropods in cotton in 1999 although not to the extent observed in the previous growing seasons. The positive response of thrips to cotton fields with borders is interesting considering all fields received an in-furrow aldicarb application. Our sampling technique may have measured transient adult populations that probably did not persist. Additional sampling would have been useful but was not logistically feasible. Borders did not appear to enhance the numbers of the primary pestiferous insects: bollworms, tarnished plant bugs and stinkbugs.

The rapid recovery of lacewings and big-eyed bugs following a pyrethroid application in cotton fields with borders suggested that the borders acted as a source or refugia for recolonization. This recolonization could contribute to biological control following the application of a broad-spectrum insecticide.

The effects of field borders around soybean fields were not as definitive as in cotton fields. In 1999 only damsel bugs responded to the treatments; they were more abundant in fields without borders. Damsel bugs recovered significantly faster in fields without borders following a pyrethroid application. This observation is intriguing and should be pursued further.

The pitfall trapping results from 1998 indicate that spiders were positively influenced by borders while tiger beetles were negatively influenced by the presence of field borders. The increase in tiger beetles in fields without borders is understandable due to their habitat preferences. Orthopterans, particularly gryllidae, are not considered a pest or are only a pest of minor importance. They do however represent a readily available and prominent food source for insectivorous birds and mammals in fields with borders. Crickets were more abundant in fields with borders, supporting the implementation of field borders as a wildlife habitat improvement for game birds in particular.

The presence of field borders around soybeans did not increase the abundance of any pest species in our samples. Excluding thrips, the presence of field borders did not appear to contribute to the abundance of pestiferous insects detected in cotton in 1999. These findings indicate that the implementation of field borders should not cause economically harmful crop damage.

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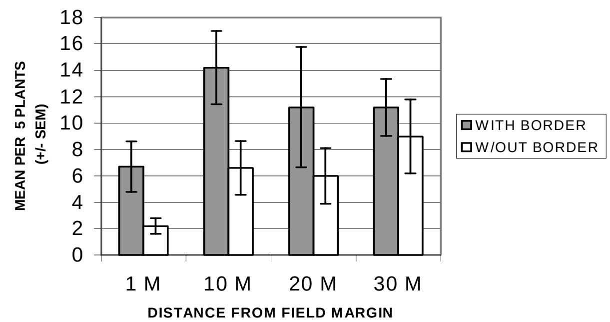

Figure 1. Occurrence of thrips in cotton at varying distances from the field margin in 1999.

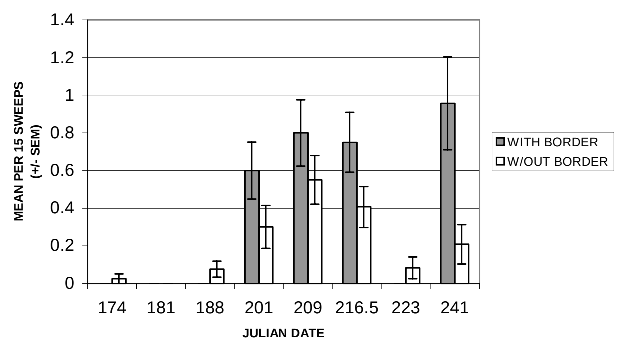

Figure 2. Sweep net occurrences of green lacewings in cotton in 1999 in fields with and without borders.

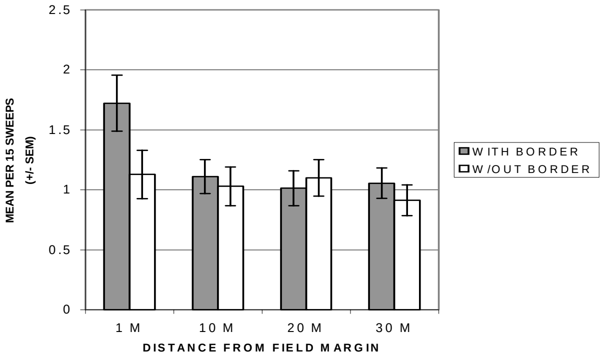

Figure 3. Sweep net occurrences of spiders in cotton in 1999 at varying distances from the field margin.

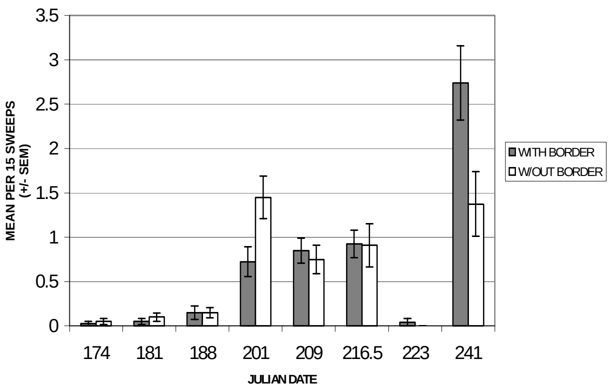

Figure 4. Sweep net occurrences of minute pirate bugs in cotton in 1999 in fields with and without borders.

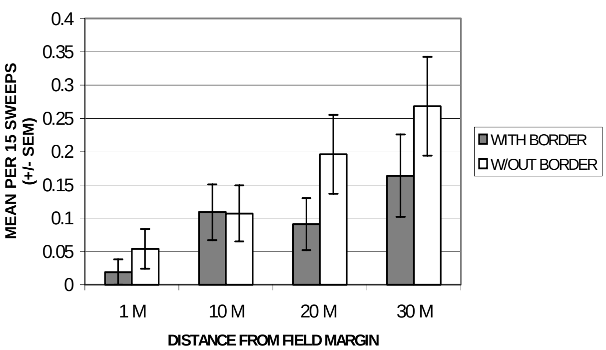

Figure 5. Sweep net occurrences of damsel bugs in soybeans in 1999 at varying distances from the field margins.

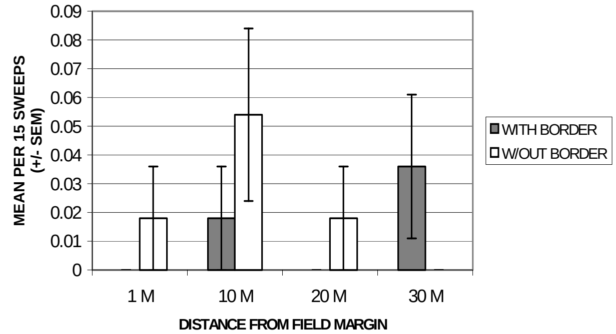

Figure 6. Sweep net occurrences of bean leaf beetles in soybeans in 1999 at varying distances from the field margins.

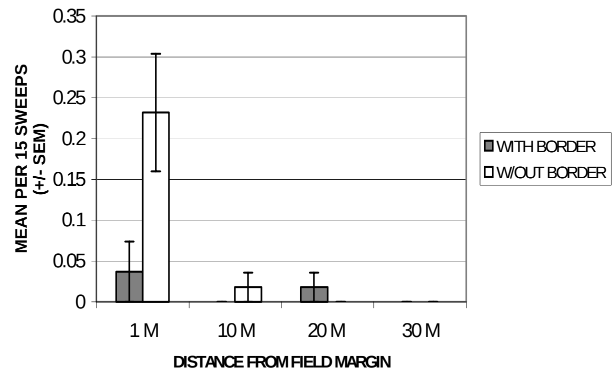

Figure 7. Sweep net occurrences of green cloverworms in soybeans in 1999 at varying distances from the field margins.

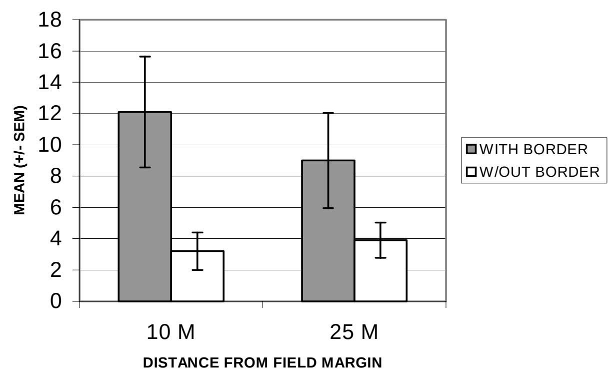

Figure 8. Pitfall trap occurrences of spiders in soybeans at varying distances from the field margin in 1998.

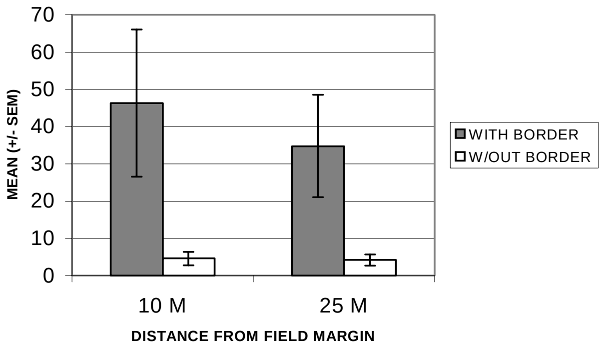

Figure 9. Pitfall trap occurrences of orthoptera in soybeans at varying distances from the field margin in 1998.

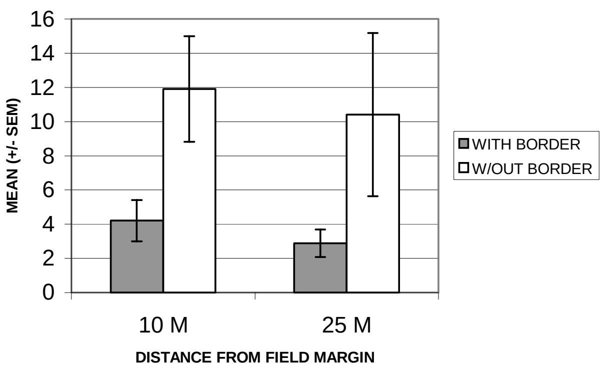

Figure 10. Pitfall trap occurrences of tiger beetles in soybeans at varying distances from the field margin in 1998.