Managing Agricultural Drainage Ditches to Improve Conservation Biological Control

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Abstract

Conservation biological control provides an alternative for a sustainable approach to managing pests by enhancing natural enemies through providing their ecological needs. To date, little research has been conducted on the natural enemies found in agricultural drainage ditches in farm fields. Here, we attempt to demonstrate the value of ditch management to improve conservation biological control for farmers. Three studies were conducted. The first one, using a sticky and pitfall traps, natural enemies were sampled weekly from cleared and uncleared ditches with potted Chinese cabbage *Brassica Rapa* plants in two locations. Similarly, the second trial was conducted in two different locations the predation rates provided by ditch resident predators was quantified using corn earworm (*Helicoverpa zea) and* cabbage looper (*Trichoplusia ni*) larvae. The third experiment cabbage plants were placed at three different distances from the cleared and uncleared ditches to evaluate the contribution of . In the first experiment there were significant number of insects that includes pests and beneficial insects collected in the uncleared ditches than the cleared one. In the second study, after 24 h of introduction of the larvae high abundances of the natural enemy population in the uncleared ditches recorded compared with the cleared ones, and on average, six larvae/plant missed in the uncleared ditch. Our results indicates that the ditch habitats may provide valuable ecosystem services to producers by enhancing natural enemies of pests and increasing their biological control.

Introduction

Agricultural drainage ditches are essential for the removal of surface and groundwater to allow for crop production in poorly drained agricultural landscapes [1]. Especially for the flat coastal plain region of the Northeast, including the Delmarva Peninsula, ditches are necessary to drain the high-water table at certain times of the year. In addition, ditch habitats may also provide valuable ecosystem services to producers by enhancing natural enemies of pests and increasing their biological control. Field and vegetable crops are common on the Delmarva, including corn, soybean, sweet corn, melons, and cold crops. These crops are attacked by many insect and arthropod pests, resulting in the need for IPM programs and often the application of insecticides throughout the Coastal Plain Region of the Northeast. Managing the agricultural ditches might contribute to managing the pests.

Objectives

- To compare natural enemy performance in ditch habitats and adjacent crop fields across a range of habitat conditions.
- To use ditches on farms to demonstrate the value of this enhancement of natural enemies for pest management.

Materials and Methods

Natural Enemy Sampling: Two Agricultural drainage ditches were selected in the Delmarva region in the Bowman road (Location-1) and Stewart Neck road (Location-2), Princess Anne, Maryland. In ditch in location-1 was between cornfields, and the ditch in location-2 was between two soybean fields. Within each location, there were uncleared and cleared ditches. In location-1, both the cleared and uncleared ditches had three 6ft apart raised beds where the *Brassica* was grown at 1.5ft spacing (Figure 1 A). At Location-2, potted Brassica plants lined the ditch. Only in location-2 in both cleared and uncleared ditches had Brassica plants positioned 0ft, 100ft, and 200ft from the ditch. In each bed or between potted plants, three 10-inch yellow sticky traps were mounted. Every week, traps were removed, and the number of beneficial insects counted and replaced. Pitfall traps were also used to trap bugs in and around ditches. Each cup received 200ml of diluted propylene glycol solution. Three cups per plot were emptied, counted, identified, and replenished weekly. The results were compared using a paired T-test between cleared and uncleared ditches.

Evaluating the activity of natural enemies: Predation rates provided by ditch resident predators were quantified using corn earworm (Helicoverpa *zea) and* cabbage looper (*Trichoplusia ni*) larvae as sentinel prey. For estimating larval predation, ten third-instars were placed on the upper leaves of four randomly selected plants per plot. After 24 h of exposure in the field, the remaining larvae were counted to determine the number of larvae consumed by predators. Moreover, the sentinel larvae were reared for parasitoid emergence. To distinguish sentinel prey predation from unknown losses due to handling and rainfall, we enclosed one plant per site in a cage that excluded natural enemies. Plants in these cages were infested with ten sentinel prey and field-collected predatory wasp, *Polistes spp* (Figure 3). Net mortality due to predation will be determined by assessing mortality from uncaged plants and subtracting it from mortality from caged plants. The experiment will be repeated three times per plot as described in [2] (Figure 2).

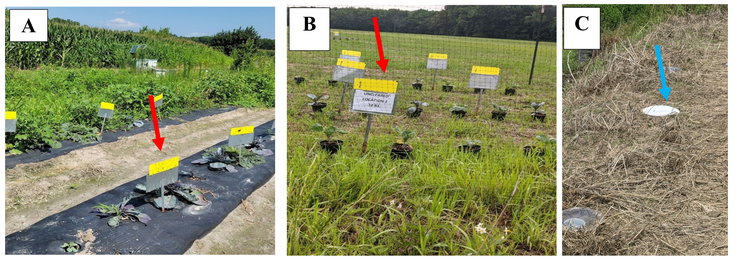

Figure 1. Location-1 where raised beds used to grow cabbages (A), location-2 the cabbage plants grown in pots (B), and the pitfall trap (C). the red arrow shows the yellow sticky trap, and the blue arrow shows the pitfall trap

Figure 2. Cages used in evaluating the activity of natural enemies

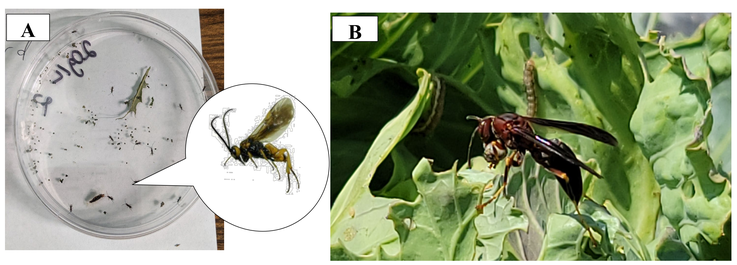

Figure 3: Parasitoids recovered from corn earworm larvae collected from field(**A**). *Polistes spp* predator preying on cabbage lopper and corn earworm larvae (**B**).

Results

The number of beneficial insects trapped with sticky traps showed significant differences between uncleared and cleared in both locations (Figure 6). The beneficial insects include soldier beetle, stinky bugs, lacewing, ladybird beetles, different types of bees, and unidentified wasps. The sticky and pitfall traps revealed that the abundance of insects are higher in uncleared ditches when compared with the cleared ditches (Figurer 5 and 6).

In the preliminary trial in location-2, the abundances of insects decrease as the distance increases from the cleared and uncleared ditches (Figure 4). However, a higher number of insects were in uncleared ditches in all distance points (Figure 4).

The number of preyed larvae was higher in the uncleared ditches in both locations, except the cabbage lopper larvae were higher in the cleared ditches (Figure 7). Interestingly, the corn earworm larvae recovered from the larval predation trial in location-1 were parasitized by braconid wasp, *Microplitis croceipes*, 41 wasps, emerged from the corn earworm larvae collected from the cabbage plants near the uncleared ditch.

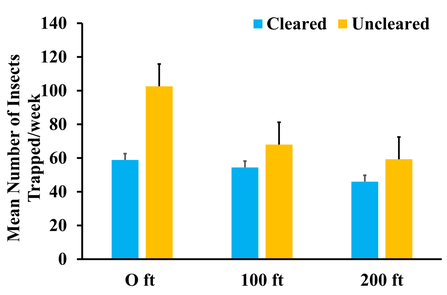

Figure 4. The mean number of pest and beneficial insects trapped at 0, 100, and 200 feet away from cleared and cleared ditches in location-2.

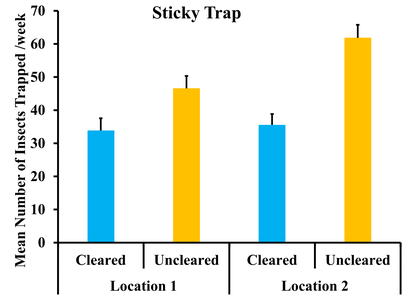

Figure 5. The mean number of beneficial insects trapped with yellow sticky trap from cleared and cleared ditches in location-1 and 2.

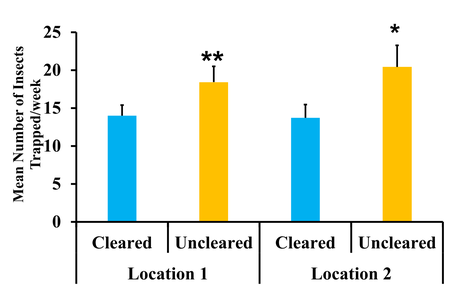

Figure 6. The mean number of crawling insects trapped with pitfall trap from cleared and cleared ditches in location-1 and 2. A paired T-test between cleared and uncleared ditches, *p<0.05, **p<0.01.

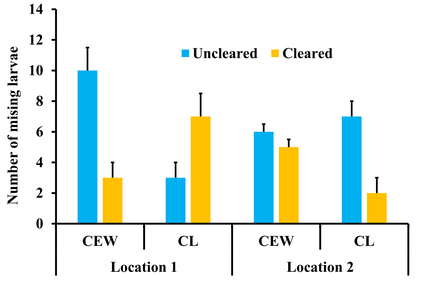

Figure 7. The number of missing Corn Earworm (CEW) and Cabbage lopper larvae on cleared and cleared ditches in location-1 and 2.

Conclusion

The presence of vegetation in uncleared ditches created a habitat and a food source for insects, which resulted in a higher level of the insect population. The level of natural enemies was higher in uncleared plots when compared with the cleared plot. The vegetation in the uncleared plot includes narrow-leaved grasses, mainly the Eragrotis family, and the broad-leaved flowering plants include gold star flowers, queen ann lace, datura…etc. This vegetation might support the insect population. If the agricultural ditches maintained well with flowering plants, they might enhance the population of beneficial arthropods (pollinators and natural enemies).

Literature Cited

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2. Perez-Alvarez, R., Nault, B.A. & Poveda, K. Effectiveness of augmentative biological control depends on landscape context. *Sci Rep* **9,** 8664 (2019). https://doi.org/10.1038/s41598-019-45041-1

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