Evaluation of New Weed-Control Strategies on Northern Bobwhite Quail Habitat and Mortality - Jim Frederick and William Bowerman

Many farmers in the Southeastern USA have been switching from traditional tillage practices to more recently developed conservation-tillage systems that include narrow row widths and transgenic varieties. Planting herbicide-tolerant varieties in narrow rows should result in fewer weed problems in conservation tillage systems, were cultivation is generally not used for weed control. Implementing these weed-control practices in conservation tillage systems should also result in the use of more environmentally friendly herbicides, in addition to reducing soil erosion and improving soil productivity.

New production practices must be evaluated not only for their effects on pest populations, but non-targeted species as well. Besides causing shifts in weed and foliar insect populations, new weed-control practices can affect insects living on the soil surface and, hence, the wildlife that feed upon them. Over the last several decades, bobwhite quail (*Colinus virginianus*) populations have declined in the Southeastern USA, at least partially due to the use of clean tillage practices by farmers. Since quail habitat includes agricultural fields, we conducted a two-year study to examine the affects of new weed-management systems (centering on conservation tillage) on bobwhite quail food availability and habitat quality. An innovative weed-control system for use with conservation tillage was compared to a traditional production system on five split fields at the Pee Dee Research and Education Center in 2002 and 2003. Each field was divided into four sampling areas: conversation tillage system, traditional tillage system, transitional zone, and wooded habitat. Year one (Y1) split fields were all planted with doublecropped soybeans (*Glycine max* L. Merr) and year two (Y2) fields were planted half in doublecropped soybeans and half in corn (*Zea maize* L). Quail were monitored using flush counts (Y1) and radio telemetry (Y2) to understand the impacts of tillage treatment and crop selection on quail habitat use and mortality. Insects and vegetative samples were also randomly collected within these four areas to determine habitat attributes including crop canopy coverage for brood and escape cover, insect populations for food availability, and tree stand density for comparison among forested areas. All data such as field location, field characteristics, insect trap location, and forest and intermediate sampling were mapped using GPS and transferred into a GIS system for comparison and modeling.

Objectives

1. To determine how new weed-control practices for conservation tillage systems affect quail habitat use or avoidance, foraging, and mortality.

2. Identify how an innovative weed control system centered on conservation tillage, narrow row widths, and herbicide tolerant varieties affects insect populations that quail use as a major food source.

3. Assess the potential benefits of conservation and traditional tillage systems with respect to pesticide use.

Materials and Methods

Year one monitoring of bobwhite quail was conducted using flush counts, which involved four individuals walking parallel through the field separated at determined distances specific for each field. Quail observations were low in that year with only 16 birds flushed during the summer (June through August). Therefore, it was decided that quail monitoring in year 2 should be conducted using radio telemetry. Quail were trapped during the winter and early spring of 2003 under guidelines of Clemson's Animal Use and Care Protocol and trapping permits from South Carolina Department of Natural Resources (SCDNR). Baited funnel traps were constructed and placed near forest edges throughout the Pee Dee Research Center and Education Center. Quail trapping success was not sufficient to answer the objectives of our study. Therefore, pen-raised quail were used for further study and released on the 23rd of July, 5th of August, and the 19th of August. Twelve quail per field (six per side) were fitted with a 5g radio transmitter and released within each treatment field at predetermined release sites. Quail were tracked daily using homing techniques developed by White and Garrot 1993, using a 3-element yagi antenna and an ATS receiver. Bobwhite quail locations were identified according to crop and tillage treatment, border or wooded habitat. When mortality occurred, remains were located and examined to identify the type of predator that caused the mortality.

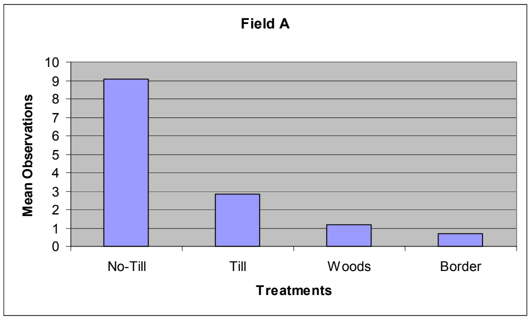
To assess crop canopy closure within treatment fields, light interception by the crop canopy was measured throughout the growing season on both sides of the fields. Pitfall insects traps were used in both years to determine differences in insect abundance between the treatment fields, border, and wooded habitat. Two pitfall traps were placed randomly in each treatment (no-till, traditional tillage, border, and woods) and collected weekly. Insects were identified to order and to family in the order Orthoptera.

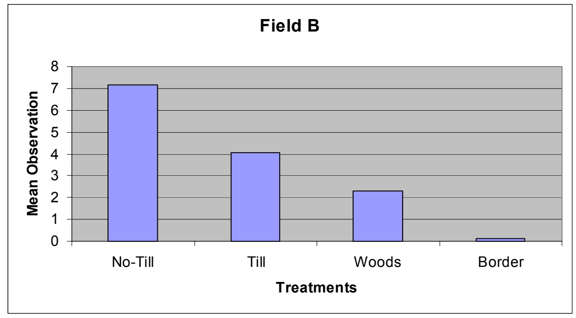
Results

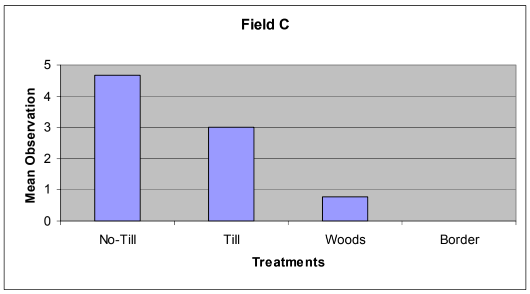
Year one (Y1) data indicated that flush counts were biased due to the assumptions that were required for this type of survey method. These assumptions included observing all quail that are present and that the quail do not move off the study site without being recorded. The result of the survey method did not indicate a habitat (crop or tillage) preference for bobwhite quail ($p > 0.05$).

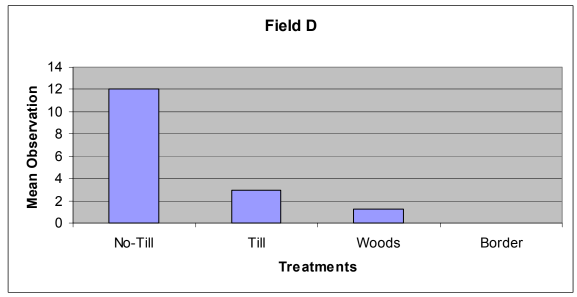
A total of 180 pen-raised quail were released and tracked with radio telemetry during the summer of 2003. Quail mortality was greater than expected compared to past research; however, this previous research was conducted in areas intensively managed for quail and releases were later in the year (September to November). The average life span for the quail released in our study was 7.68 days.

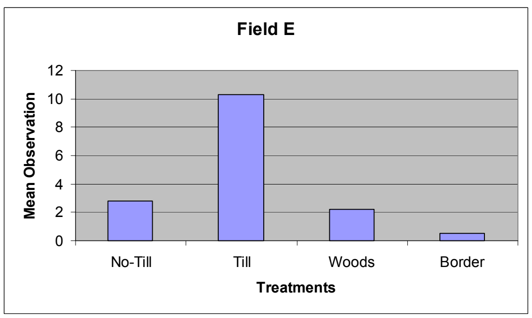
The graphs shown below are the average number of times each quail was observed in each of the treatment habitat types. The conservation tillage (CT) and traditional tillage (TT) treatments included both the corn and soybean crops.

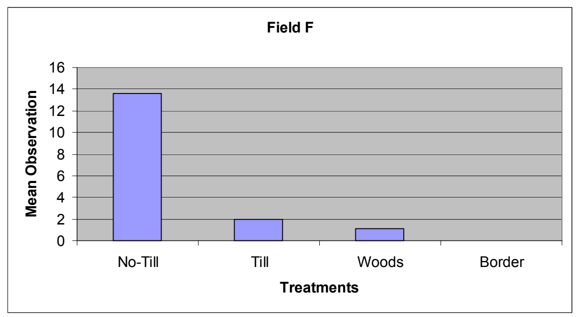












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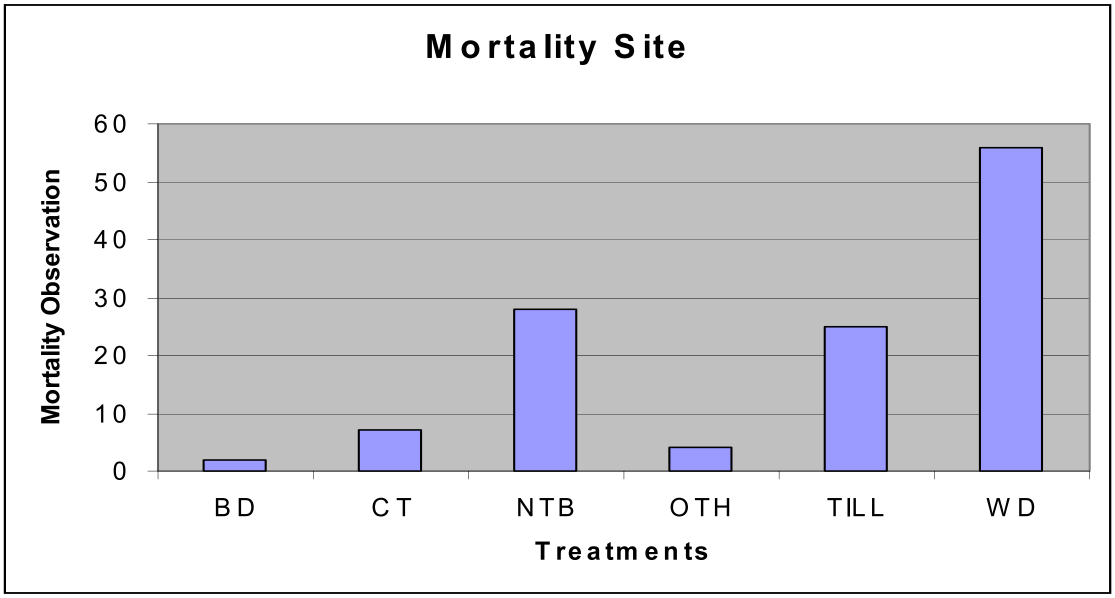
Quail were found primarily in the CT treatment (summed over soybeans and corn) for all fields except for field E. Statistics were run with SAS software using PROC GLM with an alpha level of 0.05. In fields A, B, D, and F, quail preferred the CT treatment compared to the TT treatment. Number of quail found in the CT treatment was also much higher than those found in the woods and border treatments, except field E where the differences were not significant.

Tracking data allowed for identification of treatments that resulted in the greatest number of deaths. Chi-squared analysis was used to compare the treatment areas with an alpha level of 0.05. Location in the wooded areas resulted in the greater number of mortalities. The CT and TT treatments were not significantly different; however the CT treatment resulted in a slightly higher number of mortalities (n=28, n=24).



BD= border, CO=cotton, traditional tillage, CT=conservation tillage (corn and soybean combined), OTH=other, TT=traditional tillage (corn and soybean combined), WD=woods. .

Mamalian predators accounted for 62% of the quail deaths (Tables 1 – 3). In contrast, avian kills accounted for only 29% of the deaths. Quail released on the last date survived the longest, which probably was due to the greater crop canopy development at that time, compared to the other release dates (see below).

Table 1: Mortality of Quail released in Roach Field During July and August of 2003

Release Date	Days Alive	Avian Kill %	Mammalian Kill %	Reptilian Kill %	Stress Kill %	Unknown Kill %
July 24th	4.6 days	26.5%	64.7%	2.9%	5.9%	0%
August 6th	4.3 days	58.3%	41.7%	0%	0%	0%
August 19th	8.3 days	18.2%	72.7%	0%	0%	9.1%

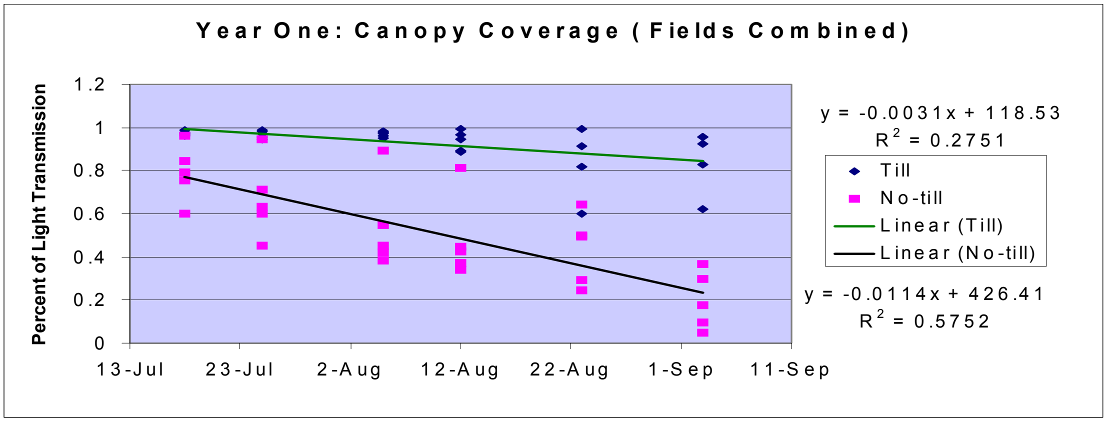
Table 2: Mortality of Quail Released in the One Hundred Acre Field During July and August of 2003

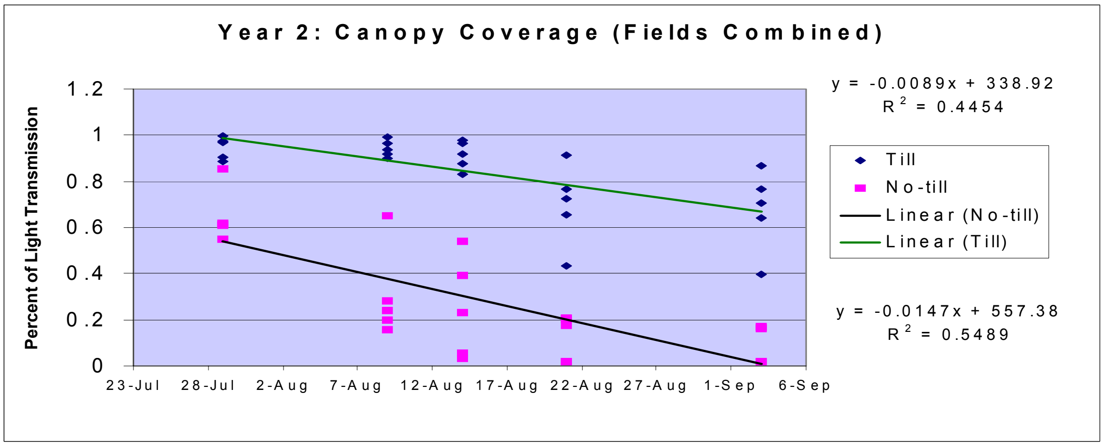
Release Date	Days Alive	Avian Kill %	Mammalian Kill %	Reptilian Kill %	Stress Kill %	Unknown Kill %
July 24th	3.5 days	12.5%	87.5%	0%	0%	0%
August 6th	8.3 days	58.3%	33.3%	0%	0%	8.3%
August 19th	8.5 days	33.3%	66.7%	0%	0%	0%

Table 3: Mortality of Quail in the Weather Station During July and August of 2003.

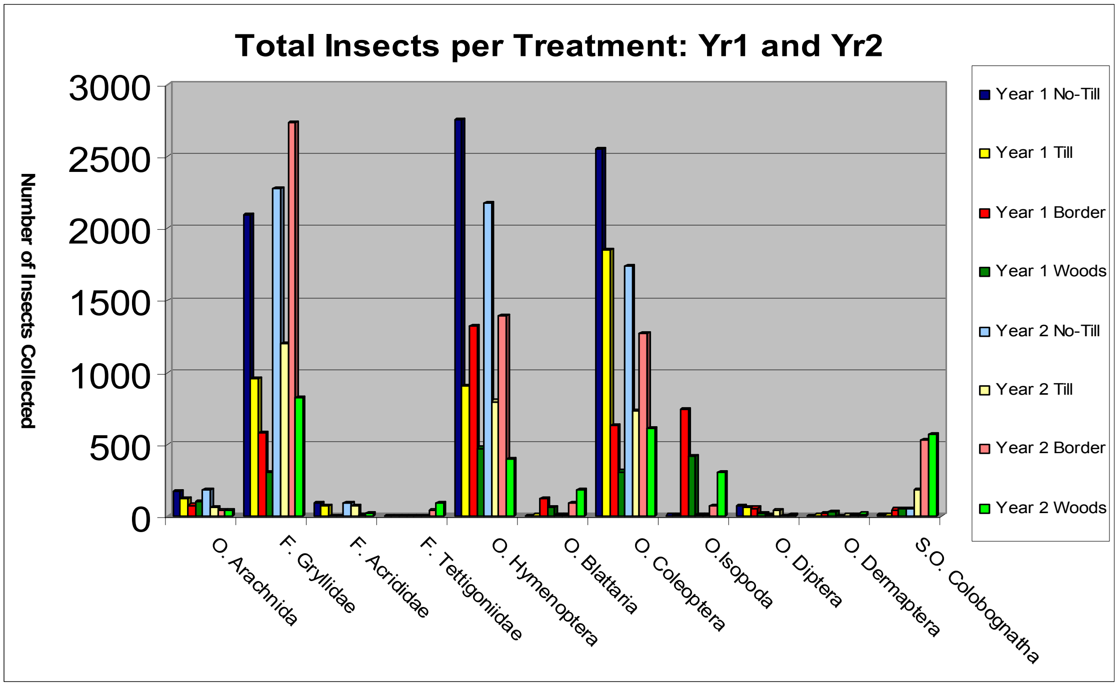
Release Date	Days Alive	Avian Kill %	Mammalian Kill %	Reptilian Kill %	Stress Kill %	Unknown Kill %
July 24th	7.1 days	11.1%	55.5%	0%	33.3%	0%
August 6th	6.4 days	9.1%	72.7%	0%	9.1%	9.1%
August 19th	14.1 days	30.0%	60.0%	0%	0%	10.0%

To compare canopy coverage of CT soybeans versus TT soybeans, crop light interception readings were taken throughout the growing season in both years. A LiCor light bar was used to collect this data. The graphs below show the results for both CT (black line) and TT (green line) soybeans. Licor reading were analyzed using chi-square analysis to compare the slopes of the trends lines shown below between tillage-system treatments. Fields were combined in the analysis step to increase the sample size for each sample data. Percent light transmission was statistically greater in TT treatments than CT treatments for each year separately and when combined over years ($p < 0.05$). These results indicate that crop canopy closure was greater and achieved earlier in the growing season for the CT treatment, thus providing quail much more protection from predators during this time.





Insects were collected weekly beginning three weeks after planting of soybean and continuing for a total of six weeks during year one and seven weeks for year two. Insects were rinsed from a field strainer and transferred into storage containers, frozen, and identified at Clemson's Institute of Environmental Toxicology Center. The majority of the insects collected were from the Order Orthoptera, mainly in the family Gryllidae (crickets). The orders Hymenoptera (ants) and Coleoptera (ground beetles) also accounted for a large percentage of the insects collected in both years. The bar graph listed below is the sum of insects collected for all fields for each treatment and year.



To analyze statistically the differences that occurred between treatments and study years, Proc GLM was used to determine the means and a mean separation was preformed using least square differences (LSD) with an alpha level of 0.05.

Field	Year	Trt	O. Arachnida	F.Gryllidae	O.Hymenoptera	O.Blattaria	O.Coleoptera	O.Isopoda	S.O.Colobognatha
A	1	No-till	2.500 (A)	63.667 (A)	25.000 (AB)	0.000 (D)	47.167 (A)	0.0167 (CD)	0.0833 (A)
A	1	Till	0.500 (BC)	38.833 (B)	30.417 (A)	0.000 (D)	22.250 (B)	0.000 (D)	0.0833 (A)
A	1	Border	0.583 (BC)	5.833 (D)	23.750 (AB)	0.250 (B)	5.250 (C)	3.250 (AB)	0.0833 (A)
A	1	Woods	1.667 (BA)	0.417 (D)	7.917 (BC)	0.417(B)	5.667 (C)	4.083 (A)	0.333 (A)
A	2	No-till	1.285 (ABC)	24.857 (C)	2.286 (C)	0.000 (D)	13.714 (BC)	0.000 (D)	0.000 (A)
A	2	Till	0.500 (BC)	24.500 (C)	3.929 (C)	0.000 (D)	7.357 (C)	0.2857 (CD)	0.000 (A)
A	2	Border	0.357 (C)	21.357 (C)	22.571 (AB)	0.214 (C)	5.071 (C)	0.214 (CD)	0.000 (A)
A	2	Woods	0.4286 (BC)	8.00 (D)	5.071 (C)	1.071 (A)	4.643 (C)	1.785 (BC)	0.2857 (A)
B	1	No-till	2.250 (BA)	22.750 (B)	39.750 (A)	0.000 (C)	48.170 (AB)	0.000 (A)	0.333 (A)
B	1	Till	2.167 (BA)	5.250 (CB)	13.917 (B)	0.167 (C)	61.500 (A)	0.333 (A)	0.000 (A)
B	1	Border	1.833 (BA)	8.333 (CB)	19.917 (AB)	3.500 (A)	14.750 (C)	6.833 (A)	0.250 (A)
B	1	Woods	2.416 (BA)	3.583 (C)	6.167 (B)	1.083 (BC)	5.330 (C)	6.333 (A)	0.166 (A)
B	2	No-till	2.857 (A)	47.357 (A)	23.714 (AB)	0.285 (C)	27.79 (BC)	0.286 (A)	1.142 (A)
B	2	Till	1.214 (BA)	18.786 (CB)	7.571 (B)	0.142 (C)	15.93 (C)	0.143 (A)	0.714 (A)
B	2	Border	0.357 (B)	20.786 (CB)	4.286 (B)	1.214 (BC)	11.29 (C)	2.000 (A)	0.071 (A)
B	2	Woods	0.571 (B)	6.143 (CB)	2.714 (B)	3.214 (AB)	8.570 (C)	5.367 (A)	1.500 (A)

C	1	No-till	3.833 (A)	44.25 (B)	16.500 (AB)	0.000 (D)	53.500 (A)	0.167 (C)	0.333 (B)
C	1	Till	1.417 (BA)	10.67 (C)	5.833 (BC)	0.333 (CD)	29.500 (B)	0.417 (C)	0.000 (B)
C	1	Border	1.117 (BA)	21.17 (CB)	14.850 (AB)	4.183 (A)	16.067 (C)	15.333 (A)	2.433 (B)
C	1	Woods	1.500 (BA)	15.420 (CB)	10.250 (BC)	1.750 (BC)	7.250 (C)	8.585 (B)	3.500 (B)
C	2	No-till	3.786 (A)	29.360 (CB)	24.500 (A)	0.285 (CD)	7.250 (C)	0.000 (C)	1.357 (B)
C	2	Till	1.000 (BA)	6.140 (C)	2.571 (C)	0.000 (D)	18.286 (BC)	0.071 (C)	11.786 (B)
C	2	Border	0.786(BA)	93.210 (A)	6.357 (BC)	1.428 (BCD)	9.000 (C)	1.174 (C)	35.929 (A)
C	2	Woods	0.071 (B)	16.670 (CB)	1.471 (C)	2.885 (AB)	6.029 (C)	1.014 (C)	47.029 (A)

D	1	No-till	3.167 (A)	31.083 (ABC)	107.580 (A)	0.0833 (B)	41.167 (A)	0.167 (C)	0.000 (B)
D	1	Till	4.083 (A)	15.667 (CDE)	20.080 (B)	0.000 (B)	21.750 (B)	0.000 (C)	0.0833 (AB)
D	1	Border	1.167 (B)	8.917 (ED)	40.420 (B)	1.000 (AB)	14.750 (BCD)	16.417 (A)	0.000 (B)
D	1	Woods	1.167 (B)	3.330 (E)	10.330 (B)	0.667 (B)	5.167 (E)	13.038 (AB)	0.250 (A)
D	2	No-till	3.500 (A)	47.214 (A)	60.640 (AB)	0.142 (B)	18.857 (BC)	0.071 (C)	0.000 (B)
D	2	Till	0.357 (B)	22.429 (ABC)	38.070 (B)	0.214 (B)	11.071 (DE)	0.071 (C)	0.071 (AB)
D	2	Border	0.500 (B)	34.000 (AB)	52.210 (AB)	1.285 (AB)	23.429 (B)	0.286 (C)	0.701 (AB)
D	2	Woods	0.500 (B)	13.357 (CDE)	13.290 (B)	2.285 (A)	8.714 (DE)	2.214 (BC)	0.000 (B)

The Order Arachnida (spiders) did not show many differences for comparisons between treatments or years for fields B, C, and D. In field A, the CT year 1 (Y1) treatment was significantly different than all other treatments except the CT year 2 (Y2) treatment. The Family Gryllidae (crickets) was highly variable between fields, but showed the highest means for CT treatment (Y1 and Y2) for all fields except field C where the highest mean was collected in the border treatment. The same pattern of highest means were recorded for the Order Hymenoptera (ants) in the CT treatment for all fields, except in field A, were CT Y2 treatment had the lowest mean for all treatments. In fields B and D, CT Y1 treatment was significantly different than TT Y1treatment. Woods (Y1) and border (Y1) treatments did not show significant differences for tillage treatment; however in Y2, significant differences were found between theses treatments in fields A and C. For the Order Coleoptera (ground beetles), CT Y1 was significantly greater than all other treatments except for field B, were TT Y1 had a greater mean. Y1 tillage treatments were significantly greater than woods and border for all fields, except field D. The CT Y2 treatment means were greater than TT Y2 treatment means for all fields except field C; however, only field D showed a significant difference between these two treatments. The border treatment in field D again showed an increased mean when compared to the other field border treatments, indicating a highly productive area for insects and diversity. The Order Isopoda and Superoder Colobognatha (centipedes and millipedes) were both highly variable due to low means, but showed trends of woods and border treatments being the main areas where these insects could be found. In Y1, fields A, B, and C had significantly greater means for the Order Isopoda in woods and border versus the tillage treatments. Only field A showed similar results for Y2. For the Superorder Colobognatha, mean collection results were low for all fields except in Y2 for Field C.

DISCUSSION

Northern bobwhite quail have been a popular game species throughout the southeastern USA. However, due to variables such as habitat loss, increased predator pressures, pesticide-use, and changing agricultural practices, their numbers have declined over the past several decades. Bobwhite quail are an edge species that prefer young growth or early successional habitat, which is why crop fields are frequently used by quail. Consequently, agricultural practices can potentially have a big impact on the quality of quail habitat.

The Pee Dee Research and Education Center has been managed in a manner similar to most modern farms in the region, using practices that are termed clean farming. Field edges and drainage ditches are mowed on a regular basis, the crop fields are planted close to the wooded areas resulting in little field border area, and the woods are not managed for wildlife habitat. These practices have no doubt contributed to a less than ideal bobwhite quail population, which would account for the low flush counts and trapping success. Pen-raised quail were used in our study due to the insufficient number of wild birds captured. The higher-than-expected mortality rate for the pen-raised birds was also probably due to less than ideal habitat at the research Center. Habitat-use was significantly greater in CT fields than the TT fields, border area, and woods. The majority of quail that entered into the wooded areas died within 48 hr; probably due to the lack of ground story cover making them very susceptible to predators. It should be noted that a major effort has been initiated at the Pee Dee REC this year to manage the woods in a more wildlife friendly manner.

The greatest and fastest crop canopy structure development occurred with the CT treatment which should have provided greater cover from avian predators, which caused the second highest mortality rates in our study. Mammalian predators (fox, bobcat, raccoon, coyote, and possum) accounted for the majority of the quail killed, followed by avian or reptile predators. The number of birds that died after being observed in a given treatment was similar for the CT and TT treatments, indicating morality rate was less with the CT treatment than the TT treatment.

Insect abundance was highly variable between years, probably due to the differences in the amount of rain received. Insects comprise the majority of food consumed by quail during the breeding season, mainly due to the high protein needed for reproduction. The Orders Hymenoptera and Coleoptera are the most frequently ingested insects by bobwhite quail, and were found to be greater in CT treatment than in TT, border, and woods treatments.

Pen-raised and native bobwhite quail should benefit from new weed-control systems centered on conservation tillage because of the greater crop cover, increased insect abundance, and more environmentally friendly herbicides that are applied with these systems. Past research has shown that native bobwhite quail will nest within soybean planted with conservation tillage; however we could not examine this observation in our studies due to the use of pen-raised quail. It is difficult to extrapolate our results to native quail due to the many difference that occur between pen-raised and native quail. However, if quail nesting and reproduction success can be increased through the use of these newer weed-control systems, it is safe to assume that the decline in native quail populations will be reduced, if not reversed. On the other hand, the impact these agronomic systems can have on quail numbers will also depend on improvements in wooded and border habitats.