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SWEET CORN BUDWORM DAMAGE AS AFFECTED BY TILLAGE[1]

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Abstract. **The influence of tillage system upon budworm damage to spring planted 'Silver Queen' sweet corn** (Zea mays **var.** rugosa) **was investigated at Gainesville, Fl. in 1980. Results indicated no difference in plant damage between minimum and conventional tillage. Damage did increase significantly with time, however the response to time of the two tillage systems studied was the same.**

A rapidly growing interest in minimum or no-tillage cropping systems has occurred in recent years throughout the southeast. Energy conservation, reduced irrigation requirements, increased land use, reduced soil erosion and decreased soil compaction are advantages of these tillage methods. The higher producer-managerial skills required and increased pest activity are, however, disadvantages to no-till or minimum tillage cropping systems (12). More severe insect infestations and greater control difficulty are problems generally anticipated with no-till or minimum tillage systems as compared to conventional production techniques (11). The no-till plant residues and lack of soil disturbance provide favorable conditions for higher insect populations (8). The principal insect pests in the south associated with foliage and ear damage to corn include but are not limited to, the fall armyworm *Spodoptera frugiperda*, the true armyworm *Pseudaletia unipuncta* and the corn earworm *Heliothis zea* (2). Varietal resistance due to plant vigor and tolerance of some cultivars of sweet corn (*Zea mays* var. *rugosa*) to the fall armyworm has been demonstrated by Brett and Bastida (6). Thus, a study was initiated to determine the effect of a mulched, minimum tillage production system upon damage due to whorl and earfeeding insects in a sweet corn cultivar recommended for Florida conditions.

Materials and Methods

'Silver Queen' sweet corn was planted in Gainesville, Fla. in the spring of 1980 on a Sparr variant soil (loamy, siliceous, hyperthermic, Grossarenic, Paleudult) utilizing a split-block experimental design with 4 replications. Two tillage systems, conventional and minimum tillage, were employed as treatments. A rye (*Secale cereale* L.) cover crop was established 3 months prior to planting the main crop by broadcasting seed and fertilizer (6-8-8 + micronutrients at 200 lb.[1]/acre), followed by a light, 3 inch discing for incorporation. Conventional tillage plots were double disced three, two and one week prior to and again at the time of planting to allow thorough decomposition of cover crop material. Paraquat (1, 1'-dimethyl-4,4'-bypyridinium dichloride) at 1 lb./acre active ingredient (a.i.), with X-77 surfactant at 1 pint/acre, was applied to all plots just prior to planting to kill any remaining rye in the conventional tillage plots and to establish the mulch cover in the minimum tillage plots. In-row weed control was obtained in all plots by use of a tank mix of CDEC (2-chloroallyl diethyldithiocarbamate) and alachlor [2-chloro-2', 6'diethyl-N-(methoxymethyl)acetanilide] in a six-inch wide band over the row at 2 lb./acre a.i. each. One half inch of overhead irrigation was applied to incorporate the herbicides. Subsequent between-row weed control was accomplished through use of sweeps in conventional tillage plots and by post-emergent, directed application of glyphosate [N-(phosphonomethyl)glycine) at ½ lb./acre a.i. in minimum tillage plots. The conventional tillage plots also received the post-emergent, directed spray application. Six 45-ft rows/ plot, with 3-ft row and 9-inch plant spacings were planted with an Allis Chalmers 'No-Til' planter modified to allow the initial fertilizer application of 1,500 lb./acre of 6-8-8 + micronutrients to be placed in a band 4 inches deep and 6 inches to the side of the seed furrow. Two subsequent side-dressings of Chilean nitrate of soda potash (15-0-14) at 200 lb./acre were applied at 3 and 6 weeks after crop emergence. Nematodes were controlled by fensulfothion (O, O-diethyl O-[p-(methyl-sofinyl) — phenyl]-phosphorothioate) at 2 lb./acre a.i. in a 1-ft wide band applied under the press wheel of the planter. A minimum of 1 inch of water/week was insured through use of supplemental overhead irrigation as needed. No insecticides or fungicides were applied to the emerged crop. Average weekly plant damage ratings due to "budworm" (*S. frugiperda*; *P. unipuncta*; *H. zea*) were accomplished beginning one week after crop emergence and continuing for 8 weeks using a 10-class visual rating system (1 = no damage, 10 = complete loss) similar to the of Wiseman et al. (14). Data for analysis of variance of budworm damage was transformed by $\sqrt{y}$. Statistical significance was determined very conservatively in the manner of Little and Hills (9). An additional analysis of variance based upon per cent plants damaged/tillage treatment at each weekly rating and throughout the rating period was also accomplished. Forty randomly selected ears of corn per treatment at each harvest were evaluated also to determine the effect of tillage upon the numbers of ears with worms (*H. zea*; *S. frugiperda*) and the number of worms per ear. Paired t-tests were performed with $\sqrt{y + 1/2}$ data transformation to determine differences due to treatments at each of the 4 harvests and over the entire harvest period of 9 days. Marketable yield information was recorded and analysis of variance accomplished utilizing a complete block design.

Results and Discussion

Budworm infestation and damage was extremely light throughout the duration of the experiment. Analysis of variance of average plant damage indicates that the two tillage systems studied did not significantly differ from one another in amount of damage sustained for any single weekly rating period. Lema (7) reported similar findings in studies with vetch-mulched field corn under conditions of low budworm infestation. There was a tendency for greater damage in the minimum tillage plots when compared with the conventional tillage treatments early in the study (Table 1). This trend was reversed in the later weeks of the experiment when the minimum tillage plots showed less (though still not significantly different) damage than did the conventionally tilled plots. These findings are contrary to those reported by All (1) who observed reduced infestations in late-planted seedling no-till field corn when compared to conventionally grown corn. Those differences however, disappeared almost entirely after the seedlings grew above

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[1]For metric conversions, see table at the front of this volume.

the *no-till* debris. The contrary findings are most likely due to time of planting differences in the two studies which resulted in lower pest populations and less infestation. Another study by All and Gallaher (3) resulted in no differences noted in infestation of fall armyworm and corn earworm between conventionally grown and no-tillage field corn.

Table 1. Budworm damage ratings for spring planted sweet corn as affected by tillage treatment.[z]

Weeks after emergence	Tillage treatment		
	Minimum	Conventional	x̄
1	1.099	1.085	1.092a[y]
2	1.204	1.056	1.129ab
3	1.163	1.055	1.138ab
4	1.179	1.077	1.128ab
5	1.435	1.363	1.399c
6	1.194	1.245	1.219abc
7	1.208	1.348	1.277bc
8	1.27	1.425	1.346c
x̄	1.219	1.207	

[z]Average rating for ca. 700 plants/treatment each week.
[y]Means followed by different letters are significantly different (Duncan's multiple range test, 5% level).

Differences in damage ratings from week to week were revealed by analysis of variance of average weekly damage ratings. A Duncan's multiple range test was performed which indicated a significant increase in total damage occurred between four and five weeks after crop emergence (Table 1) under both tillage regimes. This was followed by a nonsignificant decrease in observed damage at week six. Both systems responded in an identical manner. The principal pest observed in whorls and on leaves was the fall armyworm. According to Sparks (13) the fall armyworm requires four weeks under ideal conditions and up to 12 weeks under unfavorable conditions to complete one life cycle. It is most voracious in its final, sixth instar stage, consuming ca. 77% of its total lifetime intake of vegetation, after which it ceases feeding and pupates. Thus a rapid increase in damage as more worms reach the final instar stage followed by a decrease in observed damage when large numbers of the insect drop off the plant to pupate in the soil might be expected about five or six weeks after crop emergence.

Although the per cent damaged plants ranged from ca. 2% to 35% in any individual replication the average per cent plants at each rating time with budworm damage was not significantly different at any week except week 4 (Table 2). At that time, the percentage of injured plants in the minimum tillage treatment was significantly greater (1% level) than in the conventional tillage treatments. Since there were no differences between treatments in average damage ratings at week 4 (Table 1), the minimum till plants received less injury per damaged plant than did the conventionally tilled corn. This difference may be due to greater predation upon herbivorous insects in the mulched, minimum tillage treatments as studies by Altieri (4) showed that corn systems mulched with rye straw had a significantly higher population of the predacious earwig *Labidura riparia* than did bare, cultivated soil.

There was no effect due to tillage method employed upon either the number of worms/ear or the per cent ears with worms according to t-tests conducted on the combined harvest data. However, a highly significant difference (1% level) occurred when tillage systems were compared at different levels of maturity (as measured by days to harvest after emergence). The minimum tillage ears contained significantly greater numbers of earworms (both *S. frugiperda* and *H. zea*) at the third harvest (73 days after emergence) than those from the conventional tillage treatment (Table 3). This difference did not occur at the next harvest and was not significant overall.

Table 2. Intensity of budworm damage for spring planted sweet corn as affected by tillage treatment.[z]

Weeks after emergence	Tillage treatment	
	Minimum (%)	Conventional (%)
1	4.43	3.06
2	2.65	2.71
3	5.68	4.49
4	5.65**[y]	2.47**[y]
5	10.79	9.27
6	5.16	6.17
7	5.7	10.31
8	5.25	7.6
x̄	5.66	5.85

[z]Based on ca. 700 plants/treatment each week.
[y]Significantly different at 1% level.

Table 3. Earworm infestation for spring planted sweet corn as affected by tillage treatment.

Days after emergence	Tillage treatment			
	(No. of worms/ear[z])		(% ears infested)	
	Minimum	Conventional	Minimum	Conventional
67	0.156	0.244	20	30
70	0.336	0.312	40	37.5
73	0.682**	0.369**[y]	70**[y]	40**[y]
76	0.959	1.012	95	97.5
x̄	0.533	0.565	56.25	51.25

[z]Average of 40 randomly selected ears/treatment.
[y]Row means significantly different at 1% level.

A comparison of marketable yields between the two production systems was made by analysis of variance which revealed a significant effect (5% level) associated with location in the field but no differences due to tillage treatment. The minimum tillage system yielded 176 and 55 crates (4½ doz. ears/crate)/acre of USDA Fancy and No. 1 grades sweet corn respectively, while the conventional tillage system produced 168 crates/acre of Fancy grade and 54 crates/acre of No. 1 ears. (Some ears with worms in the unfilled one inch tip were included as No. 1 grade). Although these yields are low when compared with other reported yields for north Florida (5), it must be remembered that pesticides were not applied, and yields may have been reduced by leaf blight, aphids, etc.

Current IFAS recommendations for commercial sweet corn production include weekly sprays for budworm control and daily spray applications (beginning with silk appearance and continuing through harvest, during the production period of Mar. - Oct.) for control of earworms (10). This study indicates that under conditions of extremely light budworm infestation, production of spring-planted sweet corn is possible with a complete absence of insecticidal sprays, under either a minimum tillage or conventional tillage regime. Certainly, adequate yields may be possible with a reduction in the recommended frequencies of pesticide application once threshold levels have been determined for budworm and an IPM program established.

Since the differences between conventional and minimum tillage effects upon budworm damage to either the seedling corn plant or the ear are transitory and the tillage systems studied did not differ significantly in yield, producers considering a change to a minimum tillage production system should be able to do so with a minimal concern for increased severity of this particular pest problem. This is not to say however that further studies on other pests and their relation to minimum tillage are not required before a general recommendation for change to that method of production can be made.

Literature Cited

1. All, J. N. 1978. Insect relationships in no-tillage cropping. *Proc. 1st. Annu. No-Till Sys. Conf.* 17-20.
2. ———. 1980. Pest management decisions in no-tillage agriculture. *Proc. 3rd. Annu. No-till Sys. Conf.* 1-6.
3. ——— and R. N. Gallaher. 1976. Insect infestations in no-tillage corn cropping systems. *J. Ga. Agr. Res.* 17(4):17-19.
4. Altieri, M. A. 1979. The design of pest stable corn agroecosystems based on the manipulation of insect populations through weed management. Ph.D. Dissertation, University of Fla., Gainesville, Fla.
5. Bassett, M. J. and J. Montelaro. 1980. Vegetable variety trial results in Florida for 1975-76-77 and recommended varieties. Institute of Food and Agricultural Sciences. University of Fla., Gainesville, Fla.
6. Brett, C. H. and R. Bastida. 1963. Resistance of sweet corn varieties to the fall armyworm, *Laphygma frugiperda. J. Econ. Entomol.* 56(2):162-167.
7. Lema, Ki-munseki. 1980. Influence of no-till and conventional tillage on insect pests and soil inhabiting predator populations in Florida soybean and corn cropping systems, Ph.D. Dissertation, University of Fla., Gainesville, Fla.
8. ———, R. N. Gallaher and S. L. Poe. 1980. Pest insects as affected by tillage methods in soybean, corn and sorghum. *Proc. 3rd. Annu. No-till Sys. Conf.* 97-107.
9. Little, T. M. and F. J. Hills. 1978. Agricultural Experimentation Design and Analysis. Wiley, New York, N.Y.
10. Montelaro, J. 1978. Sweet Corn Production Guide. Institute of Food and Agricultural Sciences, University of Fla., Gainesville, Fla.
11. Musick, G. J. Problems with no-till crops: insects. *Crops and Soils* 23(3):18-19.
12. Phillips, S. H. 1978. No-tillage, past and present. *Proc. 1st. Annu. No-till Sys. Conf.* 1-5.
13. Sparks, A. N. 1979. A review of the biology of the fall armyworm. *Fla. Entomol.* 62(2):82-87.
14. Wiseman, B. R., R. H. Painter and C. E. Wassom. 1966. Detecting corn seedling differences in the greenhouse by visual classification of damage by the fall armyworm. *J. Econ. Entomol.* 59(5):1211-1214.

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EVALUATION OF A WATER CONVEYANCE AND RECOVERY SYSTEM FOR SEEP IRRIGATION[1]

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Abstract. **Insight is provided regarding water use and investment cost in the evaluation of a water conveyance and recovery system for seep irrigation of vegetable crops. The analysis evaluates a 200 acre farm with a water management system which conveys irrigation water through PVC pipe from a holding pond to the areas irrigated. The system also has the capability to recover runoff water and pump it back to the holding pond. The quantity of water required to be pumped from the deep well was 38% of the total use, while the remainder of the water came from recovery water pumped from the catch basins, rainfall and natural ground water seepage. However, the total cost of the water conveyance and recovery system adds 72% to the costs of the water conveyance system.**

The value of Florida's vegetable production was estimated at over $758 million in 1978-79, which amounts to more than one-fifth of the total cash receipts received for all agricultural commodities (1, 3). Currently, more than 90% of Florida's vegetables are grown with the assistance of irrigation. Because of the importance and contribution of irrigation to vegetable production, any major adjustment in irrigation practices could have a large impact on Florida's agricultural sector and entire economy.

The Florida vegetable industry has expanded significantly over time primarily due to the warm climate (permitting fall, winter and spring production in most areas), and an apparently inexhaustible supply of fresh water. However, the demand for water has rapidly increased due to the growth and expansion of Florida's population, industry and agriculture. As a result of the increased demand for water over the past 30 years, water withdrawal rates often exceed the natural recharge of water supplying aquifers and a possible water deficit situation could easily develop in the future.

Therefore, the economic benefits accruing from irrigated crop production to the economy of Florida may be extended into the future by a more efficient water distribution system. In an effort to reduce water loss and to provide a demonstration of water management, the Bradenton Agricultural Research and Education Center (AREC) has constructed the facilities to convey and recover water from its 200 acre farm by utilizing PVC pipes and pumps and a reservoir for storage.

The use of the PVC pipe conveyance and recovery system has several advantages:

1. Reduces total water pumped from deep wells.
2. Reduces energy requirements and pumping costs.
3. Contributes flexibility to the irrigation system for transporting water.
4. Enables more acres to be irrigated with a given quantity of water. Of course, the PVC pipe conveyance and recovery systems have some disadvantages:
    1. PVC pipe irrigation systems require larger capital investments.
    2. Producers must learn how to manage the system.
    3. The PVC pipe irrigation system may require increased pumping pressure beyond the capacity of the existing pump for open ditch irrigation.

Analysis

This study evaluates the initial investment for installing the PVC pipe water conveyance and recovery system (2). The investment components of a PVC pipe irrigation system

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