SUBSOILING AND MINIMUM TILLAGE OF CORN ON FLORIDA FLATWOOD SOIL

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INTRODUCTION

Establishing corn (*Zea mays* L.) in unprepared seedbeds is becoming a widely practiced management procedure. Minimum or no-tillage planting of corn can significantly reduce fuel use and the time required to plant when compared to conventional tillage management. Florida has a widely diverse number of soil types, some of which have produced greater corn yield after in-row subsoiling when compared to a check. Florida flatwood soils are extensive and data on subsoiling and minimum tillage on these soils are lacking. This paper provides and discusses corn data as influenced by tillage on three Florida flatwood sites in 1979. The soil at all locations was a Pomona sand (sandy, siliceous, hyperthermic Ultic Haplaquods) having less than one percent slope.

EXPERIMENTAL PROCEDURE

Three experiments were established in 1979 on soils classified as Pomona sand. These studies were either on or adjacent to the Beef Research Unit of the Institute of Food and Agricultural Sciences, University of Florida, located about 19 km (12 miles) North of Gainesville. All experiments had two corn hybrids ('DeKalb XL78' and 'Asgrow RX114') as whole plots and in-row subsoiling versus no subsoiling as sub plots. Each was replicated three times. Tillage and planting operations were accomplished with 4600 and 5600 Ford tractors. Brown-Harden two row Superseeder frames were used for planting, one with and one without in-row subsoilers attached. Individual planters were John Deere Flexi 71 units attached to the frame.

In a single pass, corn was seeded in 76.2 cm (30 inches) wide rows at 74,130 seed/ha (30,000 seed/A) with 2.24 kg/ha (2 pound/A) active ingredient (a.i.) alachlor (Lasso) (2-chloro-2', 6'-diethyl-N-(methoxymethyl) acentanilide), 2.24 kg/ha (2 pounds/A) a.i. atrazine (2-chloro-4-ethylamino-6-isopropyl-amino-1,3, 5-triazine) and 2.24 kg/ha (2 pounds/A) a.i. carbofuran (Furadan) (2, 3-Dihydro-2, 2-dimethyl-7-benzofuranyl methylcarbamate). Corn on minimum tillage experiments also received in the herbicide tank mix 0.56 kg/ha (0.50 pounds/A) a.i. paraquat plus 0.47 L (1 pint) Ortho X77 surfactant per 378.4 L (100 gallons) of water applied. The herbicides were applied using 8004 tips spaced 50.8 cm (20 inches) apart at 2.812 kg/cm^2 (40 psi) pressure in a liquid solution of 113.52 L/ha (30 gallons/A) using water as a carrier.

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Experiment one

Land preparation for experiment one included a harrow (2.44 meter 8 foot bushog) operation followed by a moldboard plow (Ford with three 40.6 cm (16 inch) plows) operation on recently cleared land. We then broadcast 56-43.4-232.6-33.6-28 kg/ha (50–38.7–207.5–30–25 pounds/A) of N(nitrogen), P(phosphorous), K(potassium), Frit 503 trace elements and Mg(magnesium), respectively and harrowed once more on March 16 prior to planting on March 17. Plot size consisted of eight rows 76.2 meters (250 feet) long. A 23.2 sq meter (250 sq feet) area was sampled from each plot for yield determination on July 6, 1979.

Experiment two

This area had been in corn production in 1977 but was not farmed in 1978. In November of 1978 a light harrow was run over the test site but young blackberry (Rubus sp.) and other weeds were extensive when corn was planted by the minimum tillage procedures on March 17, 1979. Fertilizer was applied at planting in a 20 cm (8 inch) band over the top of the corn row at a rate of 31.4–27–78.2 kg/ha (28–24–69.7 pounds/A) N, P, and K, respectively. The plots were 6 rows wide and 30.48 meters (100 feet) in length. A 9.29 sq meter (100 sq feet) area was sampled from each plot for yield determination on July 6, 1979.

Experiment three

This area was adjacent to experiment two and had the same cropping history. This area was undisturbed, in that it had not been harrowed the previous fall as was the case in experiment two. It was covered with large fruit bearing blackberry briars and covered uniformly with other broadleaf and grassy weeds. Treatment and sampling was the same as for experiment two, however, plot length was 15.24 meters (50 feet) instead of 30.48 meters (100 feet) as for experiment two. Plots were sampled for yield determination on July 9, 1979.

Common practices

Procedures common to all studies included the sidedress application of 168 kg N/ha (150 pounds/A) when corn was 50 cm (20 inches) in height. Near the same time a post direct application of 0.28 kg/ha a.i. paraquat plus 1.121 kg/ha a.i. linuron (Lorox) (3-(3, 4-Dichlorophenyl)-l-methoxy 1–methyl–urea) and 0.47 L (1 pint) Ortho X77 surfactant per 378.4 L (100 gallons of water was made on minimum tillage experiments. Post direct herbicide treatments were not needed on experiment one because of low weed populations associated with the recently cleared land.

Plot weights of whole plants and ears were taken for dry matter, moisture and shelling percent using routine procedures. Forage yields are reported at zero moisture on a dry matter basis and grain adjusted to 15.5%.

Statistical analyses were made using taped programs for a split plot on a programmable calculator. Means were evaluated by F test.

RESULTS AND DISCUSSION

Data are given in tables 1 through 3 for yield and other variables. We have indicated treatment differences at the 80% level of probability and above. The 80% level was chosen due to the difficulty of measuring treatment difference with a small number of replications and treatments.

Both hybrids responded to subsoiling for forage yield in all experiments. This was not the case for grain yield. DeKalb *XL78* did not respond in experiment two and neither hybrid responded to subsoiling in experiment three. Grain yield was positively related to ear weight and ear weight was larger in the two minimum tillage experiments, (Tables 2 and 3) as compared to the conventional tillage test (Table 1). This was as expected since it has been shown that more soil moisture is available to corn if grown under minimum tillage as compared to conventional tillage. Since subsoiling also resulted in higher yield it can be assumed that this also was beneficial in moisture conservation and possibly better plant root distribution into the subsoil layers.

Subsoiling had the greatest benefit for corn in the conventional tillage study (Table 1). More soil moisture would be lost as a result of extra soil exposure for evaporation and lack of ground cover to reduce runoff and infiltration in the conventional tillage area. The greater response to subsoiling in experiment one indicated a greater need for subsoil water as compared to the no-tillage studies.

Yields in the no-tillage experiments were equal to or greater than in the conventional tillage test. Most inputs were equal except for the extra fertilizer used and extra fuel consumption, and time required to prepare the land €or planting in experiment one. Specific fuel consumption and time measurements for various operations have not been made for a Pomona sand but have been measured for other Florida soils. Using average values for fuel consumption and time measures for Florida sandy soils show that the various tillage regimes used in these studies vary widely as follows: (1) Conventional tillage soil preparation and planting would use an average of 34.78 L/ha (3.72 gallons/A) of diesel fuel and would take 241.91 min/ha (97.9 min/A) to perform. (2) Planting with in-row subsoiling into the conventional tillage seedbed would add 5.05 L/ha (.54 gallons/A) fuel used and would require additional time of 12.36 min/ha (5.0 min/A). (3) No-tillage would reduce fuel and time requirements tremendously. No-tillage without subsoiling required an average of 6.55 L/ha (.70 gallons/A) diesel fuel and 77.59 min/ha (31.4 min/A) to plant. (4) No-tillage with in-row subsoiling would add 6.45 L/ha (.69 gallons/A) diesel fuel used and 9.43 min/ha (41 min/A) time to plant corn.

From the fuel and time data given we can note the following: (1) To grow corn as in experiment one (non-subsoiled) it would require five times more fuel than no-tillage (non-subsoiled) as in experiments two and three, (2) it would take over three times more time to establish the crop in the conventional versus no-tillage system, and (3) it would take twice the fuel of that required for no-tillage to plant with in-row subsoiling, but would require only slightly more time to subsoil.

If farmers can obtain yields from no-tillage on flatwood soils as we obtained in these studies, significant savings in energy, equipment, and labor will result in Florida agriculture. At the same time profits would be higher because of these reduced input costs as well as 'the extra returns generated from higher yields that would likely occhr.

An additional factor that needs to be considered on flatwood soils is that if heavy rains come after the soil has been cultivated (harrowed and/or moldboard plowed) it can become so wet during the planting season that it may delay planting. The cultivated soil when wet will not support machinery. This is not a serious problem in minimum tillage situations. Thus in wet years planting time could be delayed from a few days to a few weeks under convenfional tillage. Delayed planting often results in reduced yields. Worse still would be to have the soil tilled and the fertilizer cultivated in, ready to plant then get heavy rain that delayed planting two weeks or more as happened at the Beef Research Unit in 1980. No measurements were made, but undoubtedly, considerable N and K fertilizer was lost due to leaching.

Table 1. Corn Variables as influenced by subsoiling and corn hybrids grown on a flatwood soil in a conventional tillage seed-bed, Gainesville, Florida, 1979. (Exp. 1).

	Subsoil			Subsoil		
Variety	Yes	No	Mean	Yes	No	Mean
	Dry forage yield kg/ha			Grain yield kg/ha		
DeKalb XL78	18,699	15,993	17,346a	7,044a	6,755a+	6,900
Asgrow RX114	18,650	15,890	17,270a	6,077a	4,708a+	5,393
Mean	18,675	15,942*		6,561	5,732**	
	Percentage grain in forage			Ear weight in grams		
DeKalb XL78	31.8a	32.1aNS	32.0	134	103	119a
Asgrow RX114	30.6a	25.0b*	27.8	130	87	109a
Mean	31.2	28.6		132	95**	
	Number plants/ha			Number ears/ha		
DeKalb XL78	57,564	56,531	57,048b	52,828	58,856	55,842a
Asgrow RX114	59,717	65,314	62,516a	52,225	54,378	53,381a
Mean	58,641	60,923NS		52,527	56,617*	
	Plant height in cm			Ear node height in cm		
DeKalb XL78	251a	259aNS	255	81	86	84b
Asgrow RX114	265a	239b++	252	91	98	95a
Mean	258	249		86	92NS	

NS=Non significant
+ = Significant interaction at the 80% level of probability.
++ = Significant interaction at the 90% level of probability.
* = Significant interaction at the 95% level of probability or between the tillage treatment.
** = Significant differences at the 99% level between tillage treatments.
letters = Values between hybrids followed by different letters are significantly different at the 95% level of probability.

Multiply kg/ha by 0.89 to get pounds/A.
Multiply number/ha by 0.405 to get numbers/A.
Divide grams by 454 to get pounds.
Divide cm by 2.54 to get inches.

Table 2. Corn variables as influenced by subsoiling and corn Hybrids on a flatwood soil in a non-tilled seedbed, Gainesville, Florida, 1979. (Exp. 2).

	Subsoil			Subsoil		
Variety	Yes	No	Mean	Yes	No	Mean
	Dry forage yield kg/ha			Grain yield kg/ha		
DeKalb XL78	22,221	20,822	21,522a	9,209	9,121	9,165a
ksgrow RX114	18,613	17,668	18,14lb+	7,734	7,539	7,637b++
Mean	20,417	19,245+		8.472	8.330NS	
	Percentage grain in forage			Ear weight in grams		
DeKalb XL78	35.0	37.0	36.0a	153	154	154a+
Asgrow RX114	35.1	36.1	35.6a	145	137	141b
Mean	35.1	36.6NS		149	146NS	
	Number plants/ha			Number ears/ha		
DeKalb XL78	60,600	61,676	61,138a	60,600	59,200	59,900a
Asgrow RX114	55,971	51,666	53,819a	54,895	55,218	55,057a
Mean	58,286	56,671NS		57,748	57,209NS	
	Plant height in cm			Ear node height in cm		
DeKalb XL78	272	266	269a	97	96	97a
Asgrow RX114	268	252	260a	97	102	lOOa
Mean	270	259NS		97	99NS	

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Multiply kg/ha by 0.89 to get pounds/A.
Multiply number/ha by 0.405 to get numbers/A.
Divide grams by 454 to get pounds.
Divide cm by 2.54 to get inches.

Table 3. Corn variables as influenced by subsoiling and corn hybrids on a flatwood soil in a non-tilled seedbed, Gainesville, Florida, 1979. (Exp. 3).

Variety	Subsoil Yes	Subsoil No	Mean	Subsoil Yes	Subsoil No	Mean
	Dry forage yield kg/ha			Grain yield kg/ha		
DeKalb XL78	15,542	14,629	15,086a	7,144a	7,232a NS	7,188
Asgrow RX114	16,793	14,751	15,772a	7,389a	6,089a+	6,739
Mean	16.168	14.690++		7,267	6,661	
	Percentage grain in forage			Ear weight in grams		
DeKalb XL78	38.8	41.8a++	40.3	154a	150a NS	152
Asgrow RX114	37.2	34.96++	36.1	162a	130b++	146
Mean	38.0	38.4		158	140	
	Number plants/ha			Number ears/ha		
DeKalb XL78	42,732	46,284	44,508a	47,360	47,683	47,522a
Asgrow RX114	40,364	48,437	44,401a	45,530	46,607	46,069a
Mean	41,548	47,361 NS		46.445	47,145 NS	
	Plant height in cm			Ear node height in cm		
DeKalb XL78	256	252	254a	85	76	81a
Asgrow RX114	255	246	251a	99	86	93a
Mean	256	249 NS		92	81 NS	

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Divide cm by 2.54 to get inches.