Weed Management in Strip-tilled Irish Potato and Sweetpotato Systems

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Additional index words. herbicide use, soil temperature

Summary. Experiments were conducted to evaluate the effect of tillage systems and weed management on weed suppression and potato yield. Strip-tillage (ST) and conventional-tillage (CT) systems produced equal yields of Irish potato (*Solanum tuberosum* L.) or sweetpotato [*Ipomoea batatas* (L.) Lam.] when herbicide treatments were applied. Weeds in the nontreated control reduced yield of Irish potato and prevented storage root growth in sweetpotato. Excellent control of broadleaf signalgrass [*Brachiaria platyphylla* (Griseb.) Nash], henbit (*Lamium amplexicaule* L.), prickly sida (*Sida spinosa* L.), and common ragweed (*Ambrosia artemisiifolia* L.) was obtained with metribuzin + metolachlor applied preemergence at Irish potato planting, followed by sethoxydim + crop oil applied postemergence in ST and CT systems. Redroot pigweed (*Amaranthus retroflexus* L.) control was >98% at 4 weeks after treatment but was 73% to 84% at harvest across all herbicide treatments in both tillage systems. In sweetpotato, control of black mustard [*Brassica nigra* (L.) W.J.D. Koch], goosegrass [*Eleusine indica* (L.) Gaertn.], and fall panicum [*Panicum dichotomiflorum* Michx.] was >95% throughout the growing season for all herbicide treatments in both ST and CT.

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Sweet potato and Irish potato production use chemical and mechanical methods for weed control (Dallyn, 1971; Nelson and Giles, 1989). These production practices can lead to soil erosion and water runoff. Conservation tillage uses previous crop or cover crop residue to improve soil quality and conserve soil and water (Fretz et al., 1993). Yields of vegetables grown in conservation-tillage systems have been comparable to those in conventional tillage (CT) systems (Hoyt et al., 1994).

The value of mulch for improving vegetable yields has been known for years (Werner, 1933). Surface-mulching with plant residues has been used in Nigeria to increase yam (*Dioscorea rotundata* Poir.) yields (Opara-Nadi and Lal, 1987a, 1987b) and soil moisture and to lower soil surface temperature (Maduakor et al., 1984). Although low soil temperatures in conservation tillage systems can delay emergence of an agronomic crop such as corn (*Zea mays* L.) in cool climates (Hayhoe et al., 1993), emergence of yams under tropical conditions in Nigeria was often faster with mulched ridges than with nonmulched ridges (Hahn et al., 1979). The Coastal Plain of the southeastern United States also has high soil temperatures and low soil water availability late in the growing season for Irish potato. These undesirable soil conditions could be improved with surface residue.

Strip-tillage (ST) is a method in which a portion of the soil surface is tilled and subsoiled, usually the in-row portion, and the row middles are maintained undisturbed with residues. This method provides a loose friable plant bed capable of accepting transplants from a traditional transplanter or seed piece planter used in potato planting (Hoyt et al., 1994). Numerous experiments have revealed broccoli, cabbage, tomato, and Irish potato yields similar between ST and CT systems (McKeown et al., 1988; Morse et al., 1987; Pierce and Chase, 1987; Wilcut et al., 1990; Wilhoit et al., 1990). Wallace and Bellinder (1989) reported weed control in Irish potato to be similar between reduced-tillage (tillage only to cover and hill) and CT. Irish potato yield was reduced in only one of four years in the reduced-tillage system compared to the CT system (Wallace and Bellinder, 1989, 1990). The ST system offers in-row tillage and early mechanical cultivation, which may be conducive to Irish potato emergence and early weed control. However, an ST system using cultivation and herbicides needs to be developed for Irish potato and sweetpotato so that later-season weeds can be managed.

Our objective was to develop an ST system for Irish potato and sweetpotato and to determine the response of weeds to various herbicide strategies.

Materials and methods

Two experiments were established at the North Carolina State Univ. Lake Wheeler Road Field Laboratory located near Raleigh. Each experiment had a plot size of five rows spaced 3.5 feet (1.1 m) apart and 20 feet (6.1 m) long. Treatments were replicated four times in a randomized complete-block design.

The Irish potato experiment was located on an Applying fine sandy loam soil previously cropped to field corn. The sweetpotato experiment was located on an Cecil fine sandy loam soil that was cropped previously to an alfalfa–oats pasture. Both soils are classified as clayey, kaolinitic, thermic, Typic Kanhapludults. A winter cover crop of Triticale (x *Triticosecale* Wittmack) was established in Fall 1989, grown through the winter, and then killed in the Irish potato experiment with glyphosate at 3 pounds a.i. per acre (3.36 kg·ha^{-1}) applied on 23 Mar. 1990. Because cool weather followed glyphosate application, paraquat was applied at 0.6 pound a.i. per acre (0.67 kg·ha^{-1}) on 3 Apr. 1990. Triticale in the sweetpotato experiment received paraquat at 0.6 pound a.i. per acre (0.67 kg·ha^{-1}) on 18 May 1990. The CT treatment consisted of tilling the entire plot with a rototiller rear-mounted on a tractor within 4 h before planting. ST treatments were established at the same time using a Bush-hog Ro-till (Hoyt et al., 1994).

'Atlantic' Irish potato seed pieces were hand-dropped at 12-inch (30 cm) intervals in furrows on 19 Apr. and then was covered by forming a 6-inch (15 cm) bed. 'Beauregard' sweetpotato transplants were hand-planted at 12-inch (30 cm) intervals on 25 May 1990 on 12-inch-wide (30 cm) beds. Fertilizer was applied pretillage at 65N–29P–54K for Irish potato and 30N–13P–46K (pounds per acre) for sweetpotato (73N–32P–60K and

Table 1. *Influence of tillage and herbicides on weed control and Irish potato yield.*

	Application				Weed control (%)[z]									
	Rate				Broadleaf signalgrass		Redroot pigweed		Henbit	Prickly sida	Common ragweed	Potato yield (tons/acre)		
Treatment	pound/acre	kg·ha^{-1}	Method[y]	Tillage[y]	17 May	16 July	17 May	16 July	17 May	17 May	16 July	No. 1	No. 2	Total
Weedy control				ST	0	0	0	0	0	0	0	6.4	3.4	9.9
Metribuzin	0.5	0.56	PRE	ST	98	86	99	84	100	100	100	9.0	3.0	12.0
Sethoxydim[x]	0.2	0.22	POST											
Metribuzin	0.5	0.56	PRE	ST	100	91	99	73	100	100	100	8.9	3.1	12.0
Metolachlor	2.0	2.24	PRE											
Sethoxydim	0.2	0.22	POST											
Metribuzin	0.5	0.56	PRE	CT	99	95	98	79	99	99	99	10.0	2.4	12.5
Metolachlor	2.0	2.24	PRE											
Sethoxydim	0.2	0.22	POST											
$LSD_{0.05}$					3	12	2	11	2	2	2	2.4	NS	2.5

[z]*Percent weed control with 0% = no control and 100% = control of all weeds.*
[y]*PRE = preemergence, POST = postemergence, ST = strip tillage, and CT = conventional tillage.*
[x]*Crop oil at 1 quart per acre (2.34 L·ha^{-1}) included with sethoxydim.*

34N–15P–52K in kg·ha^{-1} for Irish potato and sweetpotato, respectively). Ammonium nitrate was sidedressed at 60 pounds N per acre (67 kg·ha^{-1}) to both crops 30 d after planting (DAP). Carbofuran at 1 pound a.i. per acre (1.12 kg·ha^{-1}) was applied twice to Irish potatoes for Colorado potato beetle [*Leptinotarsa decemlineata* (Say)] control. Herbicide treatments (Tables 1 and 2) were applied in 31 gallons of water per acre (290 L·ha^{-1}) at 30 psi (20.7×10^{-4} Pa) using a CO_2-pressurized backpack sprayer. Preemergence (PRE) treatments in the Irish potato experiment were applied immediately after planting (same day), and the postemergence (POST) treatments were applied when crop was 4 to 6 inches (10 to 15 cm) tall and broadleaf signalgrass was 2 to 4 inches (5 to 10 cm) tall (29 DAP). The PRE treatments were applied after sweetpotato transplanting (same day), and the POST treatments were applied when fall panicum and goosegrass were 2 to 4 inches (5 to 10 cm) tall (24 DAP). Weed control was rated on a scale of 0% to 100%, with 0% = no control and 100% = complete control. Crop injury was rated on the same scale, with 0% = no crop injury and 100% = crop death.

Both crops were hilled when Irish potato was 4 to 6 inches (10 to 15 cm) in height and just before vining for sweetpotato. Only the tilled-strip region was hilled in the ST system, whereas the entire bed was hilled in the CT system. Irish potato was harvested on 17 July and sweetpotato on 16 Oct. using a one-row mechanical harvester. Irish potato tubers were graded into no. 1 and 2 grades (USDA, Agricultural Marketing Service, 1976) and sweetpotatoes were graded into no. 1, canners, and jumbo grades (National Sweetpotato Collaborators Group, 1989).

Because 'Atlantic' potato, used in this experiment, has a low internal heat necrosis (IHN) rating compared to other varieties used in the southeastern coastal plain (Wannamaker and Collins, 1992), measurements were made to determine if tillage affected the IHN rating. IHN was measured according to the method used by Sterrett et al. (1991), in which 1 = extreme necrosis injury and 9 = no visible necrosis. Statistical analysis was performed using the SAS analysis of variance statistical program with means separated by least significant difference at $P = 0.05$ (SAS Institute, Cary, N.C.).

Results

Irish potato. No visual injury occurred in any treatment (data not shown). Herbicide treatments in ST and CT systems gave good to excellent control of broadleaf signalgrass, redroot pigweed, henbit, common ragweed, and prickly sida (Table 1). Control of redroot pigweed was lowest at harvest across all herbicide treatments in both tillage systems. Yields of no. 1 tubers were the same for all herbicide treatments in both tillage systems, yields in herbicide treatments being greater than in the weedy control. Herbicide and CT was the only treatment in which total yield was greater than the weedy control.

The IHN rating ranged from 8.1 to 8.8 and was similar among all treatments (data not shown). According to Sterrett et al. (1991), potatoes with IHN ratings of ≤7.0 are commercially unacceptable. IHN ratings in our study were above this threshold, and tuber quality was acceptable.

Sweetpotato. Herbicides in both tillage systems provided excellent control of black mustard, goosegrass, and fall panicum until harvest (Table 2). Sweetpotato yields did not differ among herbicide treatments. Sweetpotato storage roots were not produced in the weedy control because of excessive weed competition.

Conclusions

Our experiments show that conservation tillage systems for Irish potato and sweetpotato production can be used to produce yields similar to CT. Equipment is available to produce potato and sweetpotato in an alternative cultural system such as an ST system; however, using herbicides are a critical requirement for high yields and quality. Herbicides used in our experiments gave excellent control of weed species common to the Irish potato and sweetpotato production areas of the southeastern United States. Since this research was conducted, development of ethiozin herbicide for sweetpotato has been discontinued. However, clomazone and napropamide herbicides have been registered for sweetpotato. (These herbicides may not be registered in all states or countries; therefore, they should only be considered for use in states or coun-

Table 2. *Influence of tillage and herbicides on weed control and sweetpotato yield.*

Treatment	Application Rate pound/acre	Application Rate kg·ha^{-1}	Method[y]	Tillage[y]	Weed control (%)[z] Black mustard	Fall panicum	Goosegrass	Sweetpotato yield (tons/acre) No. 1	Canner	Jumbo	Total
Weedy control				ST	0	0	0	0	0	0	0
Ethiozin	1.0	1.12	PRE	ST	96	100	100	10.7	1.5	4.3	16.4
Napropamide	1.0	1.12	PRE								
Fluazifop[x]	0.2	0.22	POST								
Ethiozin	1.0	1.12	PRE	ST	98	100	100	12.5	1.7	6.0	20.1
Fluazifop	0.2	0.22	POST								
Ethiozin	1.0	1.12	PRE	CT	99	100	100	12.3	1.6	4.7	18.6
Napropamide	1.0	1.12	PRE								
Fluazifop	0.2	0.22	POST								
$LSD_{0.05}$					6	1	1	2.7	0.6	3.7	5.0

[z]*Percent weed control on 9 July, with 0% = no control and 100% = control of all weeds.*
[y]*PRE = preemergence, POST = postemergence, ST = strip-tillage, and CT = conventional tillage.*
[x]*Crop oil at 1 quart/acre (2.34 L·ha^{-1}) included with fluazifop.*

tries where they are registered—consult extension publications or personnel in your state or country to determine herbicides that can and should be used in your area.) These herbicides give excellent PRE weed control in sweetpotato (Monks et al., 1993). Growers wishing to produce sweetpotato in a ST system should consider fields having few weeds, or they should depend on late season hand-weeding since currently no POST herbicides for controlling broadleaf weeds in sweetpotato are registered. Thus, an effective weed control program in ST sweetpotato should include 1) ≥20-inch (51 cm) tilled strip bedded 12 inches (30 cm) high, 2) PRE herbicide(s) (clomazone and napropamide) applied broadcast, 3) early cultivation, 4) POST grass herbicide (fluazifop or sethoxydim) applied to areas tilled or stripped, and 5) hand-weeding.

Because our work has been completed, rimsulfuron herbicide has been registered for use in Irish potato; however, it is being marketed only in certain states. Fortunately, in most fields an effective weed control program in ST potato can be achieved using 1) ≥20-inch (51 cm) tilled strip, 2) PRE herbicides (metalachlor and metribuzin) applied broadcast, 3) early cultivation, 4) POST grass (sethoxydim) and broadleaf (metribuzin) herbicides, and 5) hand-weeding.

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