No-Till Transplanted Watermelons in a Rye Cover Crop Compared to Conventional Tillage

SARE Grant: FNE99-263
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Coordinator: C.E. Beste, Extension Weed Specialist
Others: K.L. Everts, Extension Plant Pathologist
J.L. Linduska, Extension Entomologist
Marylee Ross, Entomological Technician
Location: Dykes Road and Toadvine Road intersection, 8A field, Wicomico Co., Maryland
Soil: Matawan loamy sand, pH 6.0
Previous Crops: 1998 sorghum
1998-1999 winter cover crop Rye (variety unspecified) planted December 23.
Soil Test: soil sampled Dec. 8, 1998, 0 to 8 inch depth, east and west side sampled separately.

	lb/A									
½ Field	OM	Mg	P_2O_5	K_2O	Ca	Zn	B	Mn	Cu	S
East	0.96	237	660	81	355	5.0	0.12	18	3.1	1.3
West	1.10	221	750	154	372	5.0	0.12	21	3.0	1.4

Fertilizer: Manure - 3 Ton/A on December 21, 1998, disced the field and planted rye, variety not specified.

Manure analysis: Poultry floor manure

	lbs/Ton											
Sample	N	NH_4N	P_2O_5	K_2O	Ca	Mg	S	Mn	Zn	Cu	Avail. Nitrogen Incorp.	Moist %
1	58.77	11.49	45.29	33.80	22.88	11.29	7.45	0.62	1.10	0.70	35.13	36.5
2	79.01	14.20	69.45	53.19	29.55	15.28	13.62	0.81	1.28	0.79	46.60	30.3

Fertilizer: Commercial fertilizer as a completely soluble fertilizer was applied several times through trickle irrigation lines laid in the row adjacent to plants. Soluble 20-20-20 + minor elements fertilizer was applied at 10 lbs/A as five applications during the growing season for a total of 50 lbs/A. One foliar fertilizer application was made on August 11 as a tank mix with herbicide and fungicide. The foliar fertilizer was soluble 16-4-16 + minor elements fertilizer applied at 10 lb/A. Total fertilizer used was 50 lbs/A of 20-20-20+ME and 10 lb/A of 16-14-16+ME.

Rye Growth: Rye planted: December 23, 1998, 1.5 bu/A
February 2, 1999: 3 inch height, 10-13 plants/sq ft.
April 3, 1999: 3 ½ to 5 ½ inch height, 50 to 60% ground cover
April 23, 1999: rye provided 90% ground cover with rye height of 8 to 16 inches. Small mustard plants with a population of over 20 plants/sq ft were growing with the rye. The population was 80% *Draba verna* and 20% mouseear cress.
April 30, 1999: Average = 16 inch height, range 10-22 inches
May 4, 1999: 40% of field: average 16 inch height, range 14-18 inches
60% of field: average 22 inch height, range 20-24 inches
Overall range of rye height was 8 to 29 inches
May 21, 1999: mostly 24 to 36 inch height, average = 30 inches

Rye Kill: May 11, 1999; Roundup 2 pints/A, entire field.

Biomass of Rye Straw: 4241 lb dry wt/A. By Reps: I=5720, II=3150, III=4755, IV=3341 lb/A dry wt.

Plowed: May 21, 1999; 9 inch depth (moldboard plow)
Rye height: 16 to 45 inches, average 30 inches

Disced: May 22, 1999 and repeated before transplanting.

Subsoiled: May 23, 1999
No-Till: 22 to 24 inch depth, one pass to be under each row. A coulter and one row planter was pulled over the subsoil slit to firm soil around the soil surface.
Plowed: Rye straw prevented subsoil knife from pulling thru the soil and this treatment could not be subsoiled.

Herbicide: May 25

		lb ai/A
Gramoxone (2.5 S)	1.25 pint/A	0.39
Command (4E)	7 fl oz/A	0.23
Sinbar	2 oz/A	0.10

Variety: Allsweet, plants have 3 leaves at planting. Root cell size, approximately 1 ½ x 1 ½ inch. Locally grown in Salisbury.

Planting: May 27 to May 28: water wheel, plain water without starter fertilizer.

Plot Size: 8 rows of approximately 600 ft length. Row width is 6 ft with plants spaced 48 inches in the row. Approximately 0.66 acres per plot.

Experimental Design: Randomized complete block with two treatments and four replications.

Treatments:
1. Conventional moldboard plow, disc and plant.
2. No-Tillage, subsoiled under the row and planted.

Trickle Tube Laid: June 3, holes spaced 8 inches with 0.5 gal/min/100 ft flow rating at 20-25 psi.

Double Well Connected for trickle irrigation: June 4 (two wells of 4 inch diameter in close proximity were pumped simultaneously by a single pump). Water was filtered after the pump.

Irrigation: Irrigation was applied as needed but delayed after transplanting to stimulate deep root growth by the watermelons. A 4-inch diameter "lay-flat" line delivered water from the wells to the center of the field and extended across the center of the field, perpendicular to the rows. Trickle tubing was connected and extended 300 ft in both directions to irrigate the rows. Irrigation was operated at 4 to 6 hour intervals to apply ≈0.5 inch/A weekly or more often as needed to supplement rainfall.

Other Pesticide Applications:

August 1, 1999 - Ridomil Gold (mefenoxam) and Benlate (benomyl)

August 11, 1999 - Poast (sethoxydim) and ManKocide (mancozeb plus copper hydroxide) and non-ionic surfactant and 16-4-16 + minor elements (10 lb/A).

August 19, 1999 - Benlate (benomyl) and Quadris (azoxystrobin) and ManKocide (mancozeb plus copper hydroxide).

Morningglory population: June 13 (weeds were counted in the row)*

	Morningglory Plants/sq ft.	
Reps	Plowed	No-Till
1	1.7	0.7
2	3.3	0.3
3	2.0	0
4	1.3	0
Avg.	2.1	0.3

*Morningglory weeds occurred primarily in soil disturbed by the subsoiler. Morningglory did not grow under the straw mulch between the rows. In the plowed areas, the morningglory population was uniformly distributed between the rows.

Cultivation: Only the plowed acres were cultivated on June 18 and July 7. All plots were hoed on June 18, 1999.

Watermelon Growth: June 24, 1999

	Average Maximum Vine Length*(inches)	
Rep	Plowed	No-Till
I	18	18
II	18	20
III	17	13
IV	13	13
Avg.	17	16
LSD 0.05	3.5	
C.V.	6.8%	

*32 plants were measured in each treatment replication.

Transplant Survivability: June 24, 1999. Approximately 1200 plants per 8 row plot (150 plants/row).

No. of Watermelon Plants per Plot				
	Plowed		No-Till	
Rep	Missing[1]	Dying*	Missing	Dying
1	22	47	45	3
2	19	45	50	2
3	33	13	330[2] (150[3])	1
4	25	4	28	6
Avg.	25	28	41[4]	3

*Dying plants were mainly caused by cultivation injury.
[1]Skipped during planting or failed to survive.
[2]1 row was omitted.
[3]Total for 6 rows.
[4]Rep 3 omitted from average.

Weed Control:

% Control (Rated September 2, 1999)

	Common Ragweed		Annual Morningglory		Grasses	
Rep	Plowed	No-Till	Plowed	No-Till	Plowed	No-Till*
1	70	70	80	70	90	55
2	50	70	0	80	95	60
3	75	50	50	0	95	90
4	50	50	0	0	95	80
Avg.	61	60	33	38	94	71

*Mr. Malone observed when rye mulch soil cover was disturbed, grass escapes occurred. Grasses present were fall panicum and large crabgrass. Weed growth occurred primarily in the zone of soil disturbed by subsoiling, By subsoiling (ripping) under the row areas earlier in the season, contact herbicides would have reduced the weed population and residual herbicides may have been more effective in no-tillage.

Disease Rating: August 17, 1999

	Disease Assessment[1] % of foliage with symptoms			
	Gummy Stem Blight		Leaf Blight (Alternaria)	
Rep	Plowed	No-Till	Plowed	No-Till
1	3	1	3	1
2	5	3	3	1
3	10	5	3	3
4	7	7	5	3
Avg	6.3	4.0	3.5	2.0
LSD 0.05	3.3		1.6	
C.V	28%		26%	

[1]Rated by Dr. K.L. Everts

Disease development was monitored from 29 June through harvest. Weather conditions were not conducive to disease development. Disease onset was late and severity remained low throughout the experiment. There were no differences in percent of tissue infected with gummy stem blight or Alternaria leaf blight.

The following insect evaluations are based on observations of 20 random plants in each plot. Rated by Marylee Ross.

Mean Number of Cucumber Beetles Per Plant			
	June 18, 1999	June 23, 1999	June 30, 1999
Plowed	0.025	0.088	0.038
No-Till	0.00	0.065	0.065

Watermelons are resistant to wilt so Cucumber Beetle is not a major concern. The threshold is 5 per plant.

Mean Number of Plants Infested with Ant/20 Plants			
	June 18, 1999	June 23, 1999	June 30, 1999
Plowed	0.25	0.50	4.00
No-Till	0.75	4.50	15.75

Ants did not appear to damage the plants. It may be that moisture attracted the ants. Damage was observed in very young transplants elsewhere. Ants will feed on the honeydew produced by aphids.

June 30, 1999		
	Mean % Plants with Mites	Mean % Plants with Aphids
Plowed	25.00	21.25
No-Till	6.25	6.25

The early season threshold on mites is when 10 - 15% of the runners show injury and live mites are present. Late season threshold is when 50% of the runners show injury and live mites are present.

The threshold on aphids is when 20% or more of the runners have 5 or more aphids on the leaves. Significantly higher numbers of Ladybird Beetles were observed in the plowed plots. Ladybirds feed on aphids.

Bees, Honey: The field contained 16 hives or 2/A in the 8-acre site.
Yield: Harvested from August 26 to September 3, 1999. Allsweet variety - average size 23 to 35 lb/melon.
Harvest and Yield Data: A portable pallet scale was used to weigh each bulk bin containing approximately 1200 lbs watermelons. One plot was harvested each day from August 26 to September 3.

Watermelon Yields:

Watermelons (lb/plot)[3]		
Rep	Plowed	No-Till
1	26,249	30,308
2	31,213	28,202[2]
3	25,223[1]	28,583
4	18,207	27,012
Avg.	25,223 (38,220 lb/A)	28,526 (43,220 lb/A)
LSD 0.05	7,719 lb/plot	
C.V.	9.0%	

[1]Missing data used due to severe crop loss in a large low wet area of the plot.
[2]Yield adjusted for 8 row yield, because one row was omitted at planting.
[3]Plot size of 0.66 acres.

Summary and Discussion

Rye is grown as a winter cover crop in Maryland to stabilize soils (reduce erosion) during winter and to capture nutrients, which leach into groundwater and eventually enter the Chesapeake Bay. Rye may be plowed in the spring with conventional tillage prior to planting or the rye may be killed with herbicides followed by no-tillage planting of crops. The latter method is used for corn and soybeans in Maryland, and this study was an evaluation of transplanted watermelons grown in an untilled rye cover crop.

Watermelons have the potential to benefit from a cover crop in a similar manner as agronomic crops. These potential benefits are moisture conservation, less plant damage from wind as physical battering, or twisting of vines and as blowing soil particles, which destroy plant tissues. Also, cover crops may provide weed suppression by excluding light for weed growth or by allelopathy.

Poultry manure was applied as a major source of nutrients for watermelons and rye was planted after manure application to capture manure nutrients during winter. Transplanting into untilled soil with a "water wheel" type of transplanter would be difficult because the water wheel mechanism uses only gravity to press a hole in loose soil for plant placement. Therefore, subsoiling was applied under each row in the no-tillage treatment as a method of narrow width tillage to loosen the soil for transplanting. After subsoiling, a single-row disc opener planter with a press wheel was used to firm the soil in the trench to provide a row area for transplanting. Then, the "water wheel" transplanter was satisfactory for planting in no-tillage conditions. Subsoiling could not be performed in conventional tillage because straw buried by the moldboard plow was wrapped on the subsoiler shank and caused excessive soil displacement. Therefore, conventional tillage areas were not subsoiled; however, the water wheel transplanter functioned well in conventional tillage.

Starter fertilizer was not added to the transplanter water.

Commercial fertilizer to supplement the manure nutrients was applied as completely soluble fertilizer dissolved in the trickle irrigation water. Fertilizer placement in the row prevented fertilization of weeds in the non-crop area of 6 ft between rows. A total of 60 lbs of soluble fertilizer was applied in this study, whereas, about 1000 lb/A of commercial fertilizers are typically broadcast for field production watermelons. Weekly, or more often as needed, irrigation of 0.5 inch per acre was applied except during periods of adequate rainfall. Operation of the trickle irrigation for 4 to 6 hours at 20-25 psi provided approximately 0.5 inch per acre of irrigation. Well water was filtered after the pump.

Disease was minimal in the study, probably due to the lack of any prolonged periods of wet, cool weather in June, July, or August (see weather data on pages 10 and 11). Diseases were monitored throughout the growing season, but were only detected on August 17 and no significant difference in watermelon disease occurred between no-tillage and conventional tillage. The disease assessment on August 17 was below levels required for any effect on yield. Trickle irrigation minimized leaf wetness during the early dry season of 1999 and probably reduced disease potential.

Insect populations of cucumber beetles were unaffected by the tillage treatment. Ant populations were greater in no-tillage; whereas, mites were of significantly less population in no-tillage compared to conventional tillage. However, these differences in insect populations were below the threshold levels for crop damage.

Rye biomass significantly reduced morningglory populations compared to conventional tillage. Subsoiling to provide a method of transplanting in no-tillage disturbed the rye straw and caused weed growth in the row. A method of transplanting without disturbing the straw would improve weed control in no-tillage rye mulch. Late season weed control indicated little difference in the two cultural methods. However, grass populations were greater in no-tillage compared to the plowed treatment. Watermelon plant growth as indicated by vine length and yields were similar for both conventional and no-tillage cultural treatments. Weed growth between rows was probably reduced by delivery of all fertilizer through trickle irrigation tubing placed in each row of watermelons.

Summary

The project has demonstrated commercial watermelon yields can be achieved with transplanted watermelons in a no-tillage rye cover crop. Also, commercial yields were obtained with the application of irrigation and soluble fertilizer through trickle irrigation tubing placed in the row on the soil surface in conventional tillage and in a no-tillage rye cover crop to effect a 20 fold reduction in fertilizer compared to traditional broadcast fertilization for field production. Early weed suppression was obtained with a rye biomass of 4200 lb/A dry weight which is typical for a rye cover crop when compared to conventional tillage. However, in this study, manure application immediately prior to an extremely late rye seeding date probably accelerated growth to provide a normal rye biomass. Although differences in insect and disease ratings and populations occurred between plowed and no-tillage treatments, the differences were below threshold levels to affect watermelon growth or yield.

No-tillage transplanted watermelons are a commercially feasible production system in a rye cover crop.

Transplanted watermelons appear to be a preferred system for crop establishment in no-tillage to obtain acceptable plant populations and early vigorous plant growth with trickle irrigation.

CLIMATOLOGICAL DATA - LESREC/SALISBURY FACILITY - 1999

	APRIL			MAY			JUNE		
	Temperature (F)		Precip.*	Temperature (F)		Precip.*	Temperature (F)		Precip.*
	Min.	Max.	Amt/type	Min.	Max.	Amt/type	Min.	Max.	Amt/type
1	56	66	0.46	42	60		68	86	
2	44	65		45	58	0.03	68	86	
3	45	68	0.37	52	58		70	86	
4	47	81		53	70		62	79	
5	39	57		50	74		53	77	
6	34	63		56	67	0.10	52	84	
7	51	72		58	82		64	91	
8	45	80		55	82		72	96	
9	46	80	0.97	54	80		68	93	
10	44	60		49	75		58	69	
11	40	49	0.25	52	75		57	76	
12	44	55		54	79		58	76	
13	40	59		53	72		66	75	0.47
14	42	66		50	60		68	85	0.13
15	40	60	0.36	48	66		64	75	0.04
16	48	67		49	69		64	73	0.03
17	42	62		56	74	0.03	61	68	0.01
18	41	61		58	75		61	73	
19	38	63		61	68	0.57	53	76	
20	43	62	0.07	55	73		59	64	0.54
21	36	59	0.07	46	78		61	67	0.20
22	50	80		55	84		60	77	
23	52	80	0.98	64	80	0.08	54	83	
24	42	58		54	75	0.06	55	82	
25	38	61		50	71		65	81	
26	43	74		50	76		67	89	
27	46	65		55	72		70	88	
28	39	61		52	82		76	84	
29	39	64		57	88		74	91	0.70
30	44	60		59	90		72	78	0.02
31				62	89				
Avg[1]	43.27	65.27		53.35	74.26		63.33	80.27	
Sum			3.53			0.87			2.14
HAV[2]	44.3	65.5	3.31	53.0	73.9	3.46	63.7	82.9	4.33

[1] Average min/max temperature from midnight to midnight

[2] HAV=Historical 10 year monthly average from 1989 to 1998 of the average daily min/max temperatures and the total precipitation by month.

* Precip. = inches of rain or melted snow/sleet from midnight to midnight.

* Type = if not specified = rain, T = trace of rain, S = Snow, SS = rain snow and sleet mixture, H = hail, SL = sleet

Unusual weather/comments: ______________________

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Reviewed by: ______________________ Date: ______________________

CLIMATOLOGICAL DATA - LESREC/SALISBURY FACILITY - 1999

	JULY			AUGUST			SEPTEMBER		
	Temperature (F)		Precip.*	Temperature (F)		Precip.*	Temperature (F)		Precip.*
	Min.	Max.	Amt/type	Min.	Max.	Amt/type	Min.	Max.	Amt/type
1	72	84	0.06	78	94		66	72	0.01
2	75	85		69	88		67	75	
3	76	90	0.18	64	87		71	77	
4	77	95		64	88		73	79	0.20
5	79	97		64	90	0.24	74	79	
6	77	98		67	87	0.01	76	85	0.30
7	79	94		67	88		73	84	1.68
8	74	90		74	93		73	84	
9	69	95		63	81		71	84	0.17
10	74	94	0.25	57	83		65	80	0.50
11	60	81		70	85	0.10	58	77	
12	61	74	0.26	69	87		54	80	
13	60	73	2.16	76	90	1.10	55	79	
14	60	72	0.06	71	84	1.00	68	79	0.04
15	60	84		70	82	1.27	68	73	0.62
16	65	89		70	86		61	76	6.18
17	66	89		71	89		55	71	
18	71	89		73	90		50	75	
19	72	90		67	86		50	75	
20	73	84		68	84	0.34	54	76	
21	68	83		64	72	0.53	55	71	0.61
22	71	87	2.20	60	77		49	62	
23	75	91		59	83		45	72	
24	74	90	0.17	66	82		55	75	
25	74	91	0.05	68	78	1.34	60	83	
26	70	87		72	85		59	80	
27	69	90		71	85	0.15	66	79	
28	71	93		70	86		69	78	
29	70	89		68	88		66	79	
30	73	93		63	68		54	68	0.76
31	74	96		64	70				
Avg[1]	70.61	88.29		67.65	84.39		62.00	76.90	
Sum			5.39			6.08			11.07
HAV[2]	69.3	86.9	4.57	66.0	85.2	4.01	60.5	78.7	3.52

[1] Average min/max temperature from midnight to midnight

[2] HAV=Historical 10 year monthly average from 1989 to 1998 of the average daily min/max temperatures and the total precipitation by month.

* Precip. = inches of rain or melted snow/sleet from midnight to midnight.

* Type = if not specified = rain, T = trace of rain, S = Snow, SS = rain snow and sleet mixture, H = hail, SL = sleet

Unusual weather/comments: September 16 was Hurricane Floyd.

Reviewed by: ______________________ Date: ______________

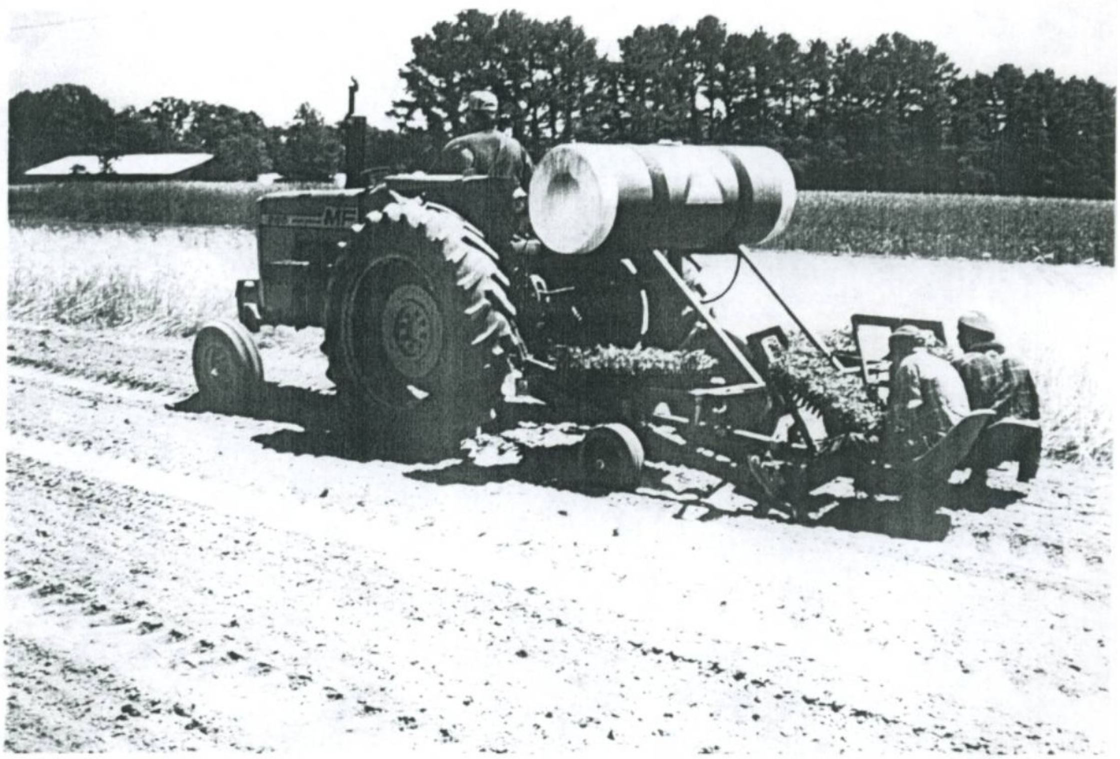

Figure 1. May 27, 1999. Water wheel transplanter planting watermelons in conventional tillage. Salisbury, Maryland (Wicomico County).

Figure 2. May 27, 1999. Watermelon transplanted in conventional tillage.

Figure 3. May 27, 1999. Watermelon transplanted in no-tillage rye cover crop.

Figure 4. May 27, 1999. No-tillage transplanted watermelon in a rye cover crop in Wicomico County, Maryland. Rows are spaced 6 feet apart.

Figure 5. June 14, 1999. Conventional tillage watermelons 18 days after transplanting. Morningglory weed population is apparent in Replication No. 2. Trickle irrigation tube is in the row on the soil surface. Row width is 6 feet.

Figure 6. June 14, 1999. Conventional tillage watermelons 18 days after transplanting. Morningglory weed population is shown before cultivation. Trickle irrigation tube is in the row on the soil surface. Replication No. 3.

Figure 7. June 14, 1999. No-tillage transplanted watermelons in a rye cover crop 18 days after transplanting. Trickle irrigation tubing is on the soil surface in the row. Replication No. 3. Note reduced morningglory population in the no-tillage compared to Figures 5 and 6 with conventional tillage.

Figure 8. June 14, 1999. No-tillage transplanted watermelons in a rye cover crop with trickle irrigation tubing in the row on the soil surface. Replication No. 3 shows variation in straw density in comparison with Figure 7. Rows are spaced 6 feet.

Figure 9. June 14, 1999. Growth of watermelons transplanted on May 27, 1999, in a no-tillage rye cover crop with trickle irrigation tubing on soil surface (18 days after transplanting).

Figure 10. June 14, 1999. Drive lane covered with rye straw between transplanted watermelon in conventional tillage and no-tillage watermelon in rye mulch. The drive lane for harvest is a skipped row and eight rows are together for harvest between the drive lanes. Four rows from each side of the plots are harvested and the fruit is transferred to bulk boxes on pallets on wagons pulled over the drive row. These rows are approximately 600 feet in length. Photograph taken 18 days after transplanting.