Integrated weed management in transplanted tomatoes and peppers under drip irrigation[1]

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ABSTRACT

Two integrated weed management experiments on tomatoes and peppers were conducted at the Fortuna Experiment Substation, Juana Díaz, P. R., in 1985–86. In the tomato experiment, the highest marketable yield and net income was obtained from plastic mulching in combination with handweeding treatment. In the pepper experiment, the highest yield and net income was obtained from plastic mulching in combination with post-directed paraquat. On the basis of yield and net income data the most suitable system for local vegetable growing was integrated weed management based on plastic mulching. The addition of a second weed control component, with either chemicals or handweeding, depends chiefly on economic considerations.

INTRODUCTION

Tomatoes and peppers rank second and third after pumpkin among vegetables of economic importance in Puerto Rico. Their commercial production amounted to 13.2 million kilograms in 1983–84 with a combined farm value of $9.27 million (1). In recent years, the use of herbicides by local vegetable growers has increased considerably. The over-reliance on chemical herbicides in tomato and pepper production can cause potentially harmful effects on public health and environment. It is therefore deemed necessary to evaluate certain integrated forms of weed control as a means to optimize yield with minimal hazard to humans and their environment.

The use of black polyethylene plastic for weed control in tomatoes was studied by Irizarry (3). This practice controlled practically all weeds with the exception of purple nutsedge (*Cyperus rotundus* L.). The high cost of plastic material has prevented its adoption for local use. However, with the introduction of low-cost plastic material in recent years, the use of plastic mulching for weed control in tomato and other vegetables is rapidly increasing in Puerto Rico. Goyal et al. (5) evaluated six plastic

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mulch types on winter and summer pepper production. They found that silver-coated black polyethylene plastic was the best mulching material for pepper production in Puerto Rico. In a preliminary study, Torres-Correa et al. (11) integrated chemical weed control with mechanical or manual weeding in one tomato experiment in Puerto Rico. In another tomato experiment, the same investigators combined four mulching materials (coffee leaves, plastic, rice straw and sugarcane trash) with chemical or manual weeding. Using the same integrated approaches, Reyes-Pérez et al. (10) conducted two integrated weed control experiments with transplanted peppers. On the basis of the results of these four field experiments, we have selected the two best mulching materials (plastics and rice straw) and the two best chemical treatments (metribuzin and napropamide for tomatoes; diphenamid and napropamide for peppers) to be further integrated with each other or integrated with either mechanical cultivation or hand weeding. Data on labor costs, cost of materials, and gross income for different weed control treatments were gathered for making an economic analysis related to our experiments.

The objectives of this investigation were (1) to determine the effects on tomato and pepper yields of mulching and chemical control alone and their integration with either manual weeding or mechanical cultivation; (2) to perform a partial budget analysis for the production of both vegetables with different integrated weed control systems.

MATERIALS AND METHODS

Tomato experiment

The experiment was conducted on a San Antón soil (33% sand, 33% silt, 34% clay, 2.1% organic matter and pH 7.1) at the Fortuna Experiment Substation, Juana Díaz, located in the semi-arid southern coast of Puerto Rico. The soil was plowed and then disc-harrowed in two directions. It was partitioned into 5.5 × 3.1 m plots. Each plot consisted of 30 tomato plants arranged in three rows. The experimental layout was a randomized complete block with four replications. Four-week-old tomato seedlings (var. Duke) were transplanted 13 December 1985, to the right-hand side of a biwall drip line. The drip irrigation system described by Goyal (4) was used in this experiment. The silver-coated black polyethylene plastic mulch was placed on the row the day before transplanting. Within 2 weeks after transplanting, enough rice straw was placed to cover the soil surface. Pre-plant application of napropamide at 4.48 kg ai/ha and metribuzin at 1.12 kg ai/ha was made 1 day before transplanting. A portable CO_2 pressurized sprayer was used for spraying napropamide and metribuzin at 2.1 kg per cm^2 pressure and 598 L/ha volume. Postemergence application of paraquat at 2.34 L/ha was directed only to weeds at a spray volume of 936 L/ha (15 January 1986 and 5 March 1986). The metribuzin + fluazifop mixture was applied simultane-

ously with paraquat. All these postemergence applications were made with a knapsack sprayer at a spray volume of 936 L/ha. Mechanical cultivation—with a rototiller for respective treatments—was performed 29 January 1986. Hand weeding for hand weeded check was made three times (14 Jan., 13 Feb. and 3 March 1986). There were four supplementary weedings for specific treatments as dictated by the economic threshold for different weed population densities for tomatoes (7). Tomato plants were staked with wild cane (*Costus spicatus*) 3 weeks after transplanting. All plants received the first application of fertilizer (10-10-8) at a rate of 224 kg/ha (28 Feb. 1986), and two applications of Nutri-leaf at a rate of 500 g in 380 liters 1 and 2 months later. Fungicides and insecticides were applied either weekly or biweekly in accordance with the recommended practices for vegetable production in Puerto Rico (2). Tomatoes were picked by hand four times at 14-day intervals beginning February 25, 1986. The weight and number of marketable tomatoes were recorded for all treatments.

The time required for herbicide application, mechanical cultivation, installation of plastic and rice straw mulching, hand weeding and harvesting was either recorded or estimated for different weed control treatments. The cost of materials (herbicides, plastics, rice straw, fuel for mechanical cultivation, etc.) was also calculated for making the corresponding economic analysis.

Pepper experiment

The experiment was conducted on the same San Antón soil (30% sand, 33% silt, 37% clay, 1.6% organic matter and pH 7.0) at the same site of the tomato experiment. The seed bed was similarly prepared and divided into the same size plots as that in the tomato experiment. Each plot consisted of 60 pepper plants arranged in six rows. Plant spacing was 0.3 m within the row. The layout of the experiment was a randomized complete block design with four replications. Six-week-old pepper seedlings (cv. Cubanelle) were transplanted 19 Feb. 1986 on both sides of a biwall drip line in a zigzag pattern at 15 cm from the drip line. The same drip irrigation system as that in the tomato experiment was used in this study. The plastic and rice straw mulches were similarly placed over the soil surface as in the case of the tomato experiment. Napropamide at 4.48 kg ai/ha and diphenamid at 11.2 kg ai/ha were applied 21 February 1986. Postemergence applications of paraquat were directed to weeds for corresponding treatments (12 March 1986, 11 April 1986 and 22 May 1986). Postemergence fluazifop-butyl at 0.56 kg ai/ha was applied 25 March 1986. Mechanical cultivation with a rototiller was done once, March 25, 1986. The hand weeded check was weeded three times (March 17, April 14, and May 22, 1986). Supplementary weedings were also performed six times for specific treatments as dictated by the economic threshold for

different weed population densities for peppers (6). Pepper plants received the first application of fertilizer (10-10-8) at the rate of 336 kg/ha 26 February 1986, and a second application of the same fertilizer at the rate of 280 kg/ha 2 months later. Fungicides and insecticides were applied weekly or biweekly in accordance with recommended practices for vegetable production in Puerto Rico (2). Peppers were picked by hand six times at 14-day intervals beginning April 21, 1986. The weight and number of marketable peppers were registered for all treatments.

The labor and material costs were similarly recorded as in the case of the tomato experiment for the performance of the economic analysis.

Economic analysis

A partial budget analysis was used to evaluate the performance of the 14 weed control treatments tested in the tomato and pepper experiments. This technique seeks to present the information in a way that facilitates the selection of the most profitable practice (9). To do this, it is not necessary to take into account those cost factors that are common among the practices under evaluation. Accordingly, only those cost factors influencing the experimental units in unequal ways were considered in the present study. The net return determined under this technique will represent that portion of the total income that remains after the deduction of the variable costs, for the payment of the common costs and for profit. The reader should keep in mind that this analysis has the major constraint of being attained by the extrapolation of small plots into per hectare basis.

RESULTS AND DISCUSSION

Tomato experiment

The highest marketable tomato yield (64,466 kg/ha) was obtained from plastic mulching plus hand weeding treatment (table 1). It was then followed by plastic mulching plus metribuzin + fluazifop-butyl mixture, plastic mulching plus paraquat, and rice straw mulching plus paraquat treatments. None of the above-mentioned treatments differed significantly at the 5% level of probability. The number of tomatoes produced in each of these four treatments followed the same order as the tomato yield in kg/ha. With most nonmulching treatments, irrespective of their integration, fewer tomatoes and lower yield were produced than with mulching treatments. Our estimated yields from the tomato experiments are apparently higher than those reported in average commercial fields (8), primarily because of border effects and the more intensive care that is possible under small plot experimental conditions.

Table 2 shows the expected economic return for the tomato experiment. The best performer, in term of net income, is the plastic mulching plus hand weeding treatment (T-11). It was followed by other mulching

TABLE 1.—*Effect of different weed control treatments on weight and number of tomatoes grown at the Fortuna Research and Development Center*[1]

Treatment	Tomato production	
	Weight	Number
	kg/ha	*no/ha*
1. Napropamide 4.48 kg ai/ha	32,348 f[2]	158,989 f[2]
2. Napropamide 4.48 kg ai/ha + Mechanical cultivation	38,004 def	202,941 ef
3. Napropamide 4.48 kg ai/ha + Hand weeding	37,647 def	191,280 ef
4. Metribuzin 1.12 kg ai/ha	39,737 def	225,589 def
5. Metribuzin 1.12 kg ai/ha + Mechanical cultivation	33,279 ef	189,935 ef
6. Metribuzin 1.12 kg ai/ha + Hand weeding	36,406 def	186,347 f
7. Hand weeded check	41,047 def	230,074 def
8. Metribuzin 0.56 kg ai/ha + Mechanical cultivation	44,151 cde	225,814 def
9. Plastic mulching + Paraquat 2.34 L/ha	55,651 ab	308,784 abc
10. Plastic mulching + (Metribuzin 0.56 kg ai/ha + Fluazifop-butyl 0.56 kg ai/ha)	56,333 ab	311,699 ab
11. Plastic mulching + Hand weeding	64,466 a	340,626 a
12. Rice straw mulching + Paraquat 2.34 L/ha	54,572 abc	290,620 abcd
13. Rice straw mulching + (Metribuzin 0.56 kg ai/ha + Fluazifop-butyl 0.56 kg ai/ha)	47,438 bcd	256,535 bcde
14. Rice straw mulching + Hand weeding	44,022 cde	246,220 cdef

[1]Weed species in the experimental plots were *Amaranthus dubius, Trianthema portulacastrum, Echinochloa colonum, Eleusine indica, Digitaria sanguinalis, Cleome gynandra, Datura stramonium, Leptochloa filiformis* and *Cyperus rotundus.*

[2]Means followed by the same letters do not differ significantly at the 0.05 level.

treatments in almost the same descending order as in the yield of tomato. Despite the highest variable costs incurred in treatments in which plastic mulching was combined with another weed control method (T-9, T-10, & T-11), the additional yield obtained was enough to compensate for these costs and to increase the net income. This compensation can be readily seen when T-11, the best performer among the mulching treatments, is compared with T-8, the best performer among nonmulching treatments; an additional investment of $2,707 (4,457–1,750) yields an expected additional income of $9,213.

TABLE 2.—*Partial budget for the production of tomatoes with several weed control treatments (dollars/ha)*

	T-1	T-2	T-3	T-4	T-5	T-6	T-7	T-8	T-9	T-10	T-11	T-12	T-13	T-14
Income														
Gross income[1]	18,438	21,662	21,459	22,650	18,964	20,751	23,396	25,166	31,721	32,109	36,746	31,106	27,040	25,093
Payroll subsidy[2]	154	230	299	184	303	293	614	275	567	522	615	412	383	545
Total gross income	18,592	21,892	21,758	22,834	19,267	21,044	24,010	25,441	32,288	32,631	37,361	31,518	27,423	25,638
Partial costs														
Herbicide application														
Materials	110	110	110	74	74	74	—	37	59	443	—	59	444	—
Labor														
Quantity	37.83	37.83	37.83	37.83	37.83	37.83	—	56.75	113.50	113.50	—	113.50	113.50	—
Cost[3]	125	125	125	125	125	125	—	187	375	375	—	375	375	—
Weeding														
Labor														
Quantity (man-hours)	—	80.00	224.25	—	247.00	221.75	809.25	95.75	86.00	—	221.75	—	—	433.50
Cost	—	264	740	—	815	732	2,671	316	284	—	732	—	—	1,431
Mechanical cultivation														
Labor-Quantity	—	16.75	—	—	16.75	—	—	16.75	—	—	—	—	—	—
Cost	—	55	—	—	55	—	—	55	—	—	—	—	—	—
Equipment cost[4]	—	25	—	—	25	—	—	25	—	—	—	—	—	—
Fuel	—	11	—	—	11	—	—	11	—	—	—	—	—	—
Plastic mulching														
Material	—	—	—	—	—	—	—	—	630	630	630	—	—	—
Labor (installation and removal)	—	—	—	—	—	—	—	—	413.75	413.75	413.75	—	—	—
Cost	—	—	—	—	—	—	—	—	1,365	1,365	1,365	—	—	—
Rice straw mulching														
Material	—	—	—	—	—	—	—	—	—	—	—	726	726	726
Labor	—	—	—	—	—	—	—	—	—	—	—	226.88	226.88	226.88
Cost	—	—	—	—	—	—	—	—	—	—	—	749	749	749
Interest on preharvest cost[5]	12	28	49	10	54	47	134	28	134	141	137	95	115	145
Harvesting cost														
Man-hours	242.25	284.50	282.00	297.50	249.25	272.50	307.50	330.75	416.75	421.75	482.75	408.75	355.25	329.75
Cost	799	939	931	982	823	899	1,015	1,091	1,375	1,392	1,593	1,349	1,172	1,088
Total variable cost	1,046	1,557	1,955	1,191	1,982	1,877	3,820	1,750	4,222	4,346	4,457	3,353	3,581	4,139
Net income[6]	17,546	20,335	19,803	21,643	17,285	19,167	20,190	23,691	28,066	28,285	32,904	28,165	23,842	21,499

[1]The price of tomatoes was set at $0.57/kg based on the average farm price for 1985.
[2]Set at $0.55/man-hours.
[3]Cost for man-hours set at $2.85 + 15.8 for fringe benefits.
[4]Allowance for depreciation, maintenance and interest on investment for a $1,006.00 roto-tiller.
[5]Interest set at 10%, since the crop cycle is 6 months, the farmer will pay half of the rate (5%).
[6]Income left for the payment of other costs and for profit.

Pepper experiment

The highest marketable pepper yield (29,494 kg/ha) was obtained from plastic mulching plus paraquat treatment (table 3). The plastic mulching plus hand weeding treatment was the only one producing comparable yield. All other weed control treatments produced significant lower yield than the above-mentioned integrated treatments. The number of peppers produced with the different treatments followed approximately the same order as with pepper yield. Again, yield in the pepper experiment is much higher than those reported in average commercial fields (8). The same explanation as in the case of the tomato experiment might hold true for the pepper experiment.

TABLE 3.—*Effect of different weed control treatments on weight and number of peppers grown at the Fortuna Research and Development Center*[1]

Treatment	Pepper production	
	Weight	Number
	kg/ha	*no/ha*
1. Napropamide 4.48 kg ai/ha	5,464 f[2]	124,680 de[2]
2. Napropamide 4.48 kg ai/ha + Mechanical cultivation	16,120 bc	441,312 bc
3. Napropamide 4.48 kg ai/ha + Hand weeding	18,943 b	570,700 b
4. Diphenamid 11.2 kg ai/ha	4,663 f	89,025 de
5. Diphenamid 11.2 kg ai/ha + Mechanical cultivation	9,702 de	280,080 cde
6. Diphenamid 11.2 kg ai/ha + Hand weeding	12,666 cd	387,717 bc
7. Hand weeded check	16,527 b	475,397 bc
8. Paraquat 2.34 L/ha early post + Fluazifop-butyl 0.56 kg ai/ha (post)	3,132 f	79,831 e
9. Plastic mulching + Paraquat 2.34 L/ha	29,494 a	791,132 a
10. Plastic mulching alone	6,971 ef	289,274 cd
11. Plastic mulching + Hand weeding	28,212 a	591,107 ab
12. Rice straw mulching + Paraquat 2.34 L/ha	16,345 bc	465,082 bc
13. Rice straw alone	3,570 f	94,407 de
14. Rice straw mulching + Hand weeding	18,956 b	563,300 b

[1]Weed species in the experimental plots were *Amaranthus dubius, Trianthema portulacastrum, Echinochloa colonum, Eleusine indica, Digitaria sanguinalis, Cleome gynandra,* and *Datura stramonium.*

[2]Means followed by the same letters do not differ significantly at the 0.05 level.

TABLE 4.—*Partial budget for the production of peppers with several weed control treatments (dollars/ha)*

	T-1	T-2	T-3	T-4	T-5	T-6	T-7	T-8	T-9	T-10	T-11	T-12	T-13	T-14
Income														
Gross income[1]	3,716	10,962	12,882	3,171	6,597	863	11,238	2,130	20,056	4,740	19,184	11,115	2,428	12,890
Payroll subsidy[2]	105	806	983	92	682	875	1,115	124	772	334	1,081	482	193	965
Total gross income	3,821	11,768	13,865	3,263	7,279	9,488	12,353	2,254	20,828	5,074	20,265	11,597	2,621	13,855
Partial costs														
Herbicide application														
Materials	110	110	110	135	135	135	—	152	89	—	—	89	—	—
Labor														
Quantity (man-hours)	37.83	37.83	37.83	37.83	37.83	37.83	—	138.50	170.25	—	—	170.25	—	—
Cost[3]	125	125	125	125	125	125	—	457	562	—	—	562	—	—
Hand weeding														
Labor														
Quantity (man-hours)	—	963.00	1,222.50	—	915.00	1,199.75	1,568.00	—	—	—	766.25	—	—	975.50
Cost	—	3,178	4.034	—	3,020	3,959	5,174	—	—	—	2,529	—	—	3,219
Mechanical cultivation														
Labor														
Quantity	—	16.75	—	—	16.75	—	—	—	—	—	—	—	—	—
Cost	—	55	—	—	55	—	—	—	—	—	—	—	—	—
Equipment cost[4]	—	25	—	—	25	—	—	—	—	—	—	—	—	—
Fuel ($0.64/hr.)	—	11	—	—	11	—	—	—	—	—	—	—	—	—
Plastic mulching														
Material	—	—	—	—	—	—	—	—	630	630	630	—	—	—
Labor (installation and removal; man-hours)	—	--	—	—	—	—	—	—	413.75	413.75	413.75	—	—	—
Cost	—	—	—	—	—	—	—	—	1,365	1,365	1,365	—	—	—
Rice straw mulching														
Material	—	—	—	—	—	—	—	—	—	—	—	726	726	726
Labor (man-hours)	—	—	—	—	—	—	—	—	—	—	—	252.00	252.00	252.00
Cost	—	—	—	—	—	—	—	—	—	—	—	832	832	832
Interest on preharvest[5]	12	174	213	13	167	211	259	30	132	100	226	110	78	239
Harvesting cost														
Labor (man-hours)	152.00	448.50	527	129.75	270.00	352.50	459.75	87.25	820.50	194.00	785.00	454.75	99.25	527.50
Cost	502	1,480	1,739	428	891	1,163	1,517	288	2,708	640	2,591	1,501	328	1,741
Total variable cost	749	5,158	6,221	701	4,429	5,593	6,950	927	5,486	2,735	7,341	3,820	1,964	6,757
Net income[6]	3,072	6,610	7,644	2,562	2,850	3,895	5,403	1,327	15,342	2,339	12,924	7,777	657	7,098

[1]The price of peppers was set at $0.68/kg based on the average farm price for 1985.
[2]Set at $0.55/man-hours.
[3]Cost for man-hours set at $2.85 + 15.8% for fringe benefits.
[4]Allowance for depreciation, maintenance and interest on investment for a $1,006.00 roto-tiller.
[5]Interest set at 10%, since the crop cycle is 6 months the farmer will pay half of the rate (5%).
[6]Income left for the payment of other costs and for profit.

Table 4 shows the expected economic return for the pepper experiment. The highest net return was obtained with plastic mulching plus paraquat treatment (T-9). It was followed by plastic mulching plus hand weeding (T-11). Although the gross incomes for both treatments were very close with no statistical difference between their yields, the cost of supplementary hand weeding in T-11 ($2,529) was substantially higher than the cost of herbicide application in T-9 ($651). When the economic return of the best plastic mulching treatment (T-9) is compared with that of the best non-plastic mulching treatment (T-12), it can be seen that with an additional investment of $1,666 ($5,486–$3,820), an additional return of $7,565 may be expected.

On the basis of yield and net income data both our experiments suggest that a plastic mulching based management is the best alternative for local vegetable growers. The addition of a second weed control component with chemical methods or hand weeding depends chiefly on economic considerations. The price of vegetables, labor costs, and cost of materials are those prevailing for the year in which these experiments were performed and will change with time and locality. Since the price structure can change the relative performance of the treatments, those adopting one of these management systems must make up their own budget.

These results should be useful for growers with soils and weather conditions similar to those prevailing in the Fortuna Substation where this study took place.

RESUMEN

Control integrado de yerbajos en tomates y pimientos trasplantados con riego por goteo

El ingreso bruto generado por el tomate y el pimiento en Puerto Rico fue de $9.27 millones en 1984–85. El desyerbo integral es de gran importancia en la producción de ambas hortalizas. En 1985–86 se realizaron dos pruebas en tomates y en pimientos en la subestación de Fortuna. En estas pruebas se usaron métodos de desyerbo integral. En tomate el mejor rendimiento y la ganancia neta más alta se obtuvieron con el tratamiento que combinó la cubierta plástica con el desyerbo a mano. En pimiento el mejor rendimiento y la ganancia neta más alta se obtuvieron con el tratamiento que combinó la cubierta plástica y la aplicación directa del posemergente paraquat. A base de los rendimientos e ingresos netos en los dos casos, recomendamos que se incluya el uso de cubierta plástica como componente básico del cultivo de estas dos hortalizas. El uso de un componente adicional, ya sean agentes químicos o desyerbo a mano, depende mayormente de las consideraciones económicas de cada agricultor.

LITERATURE CITED

1. Anonymous, 1983. Agricultural Statistics for 1983–84. Office of Statistics, Commonwealth of Puerto Rico.

2. Estación Experimental Agrícola, 1976. Conjunto Tecnológico para la Producción de Hortalizas, Univ. P. R. Publ. 102: 46–9.
3. Irizarry, H., H. Azzam and R. Woodbury, 1968. Evaluation of black polyethylene plastic mulch for tomato production in Puerto Rico. *J. Agric. Univ. P. R.* 52 (1): 52–63.
4. Goyal, M. R., 1983. Labor-input requirement for experimental production of summer peppers under drip irrigation. *J. Agric. Univ. P. R.* 67 (1): 22–7.
5. ——, R. Guadalupe-Luna, L. E. Rivera and E. R. de Hernández, 1984. Effect of plastic mulch types on crop performance of drip irrigated winter and summer peppers. *J. Agric. Univ. P. R.* 68 (3): 297–305.
6. Liu, L. C., J. González-Ibáñez and M. R. Goyal, 1985. Weed competition in transplanted sweet peppers. Proc. 20th Annu. Meet. Caribb. Food Crops Soc. 20: 198–99.
7. ——, María de Lourdes Lugo and L. Almodóvar-Vega, 1985. Weed competition in transplanted tomatoes. Proc. 21th Caribb. Food Crops Soc. Meet., 1985. (In press).
8. Llorens, A. A., E. González-Villafañe and D. Vargas, 1984. Gastos e ingresos en la producción de hortalizas en la costa sur de Puerto Rico. Esta. Exp. Agric., Univ. P. R., Bol. 274: 1–28.
9. Perrin, R. K., D. L. Winkelmann, E. R. Moscardi and J. R. Anderson, 1981. Formulación de recomendaciones a partir de datos agronómicos: Un manual metodológico de evaluación económica. CIMMYT, Publ. No. 27.
10. Reyes-Pérez, L. A., L. C. Liu, L. Almodóvar-Vega, M. R. Goyal and J. González-Ibáñez. Integrated weed control in transplanted peppers. Proc. 22th Caribb. Food Crops Soc. Meet., 1986. (In press).
11. Torres-Correa, L. M., L. C. Liu, M. R. Goyal and J. González-Ibáñez, 1985. Integrated weed control in transplanted tomatoes. Proc. 21st Annu. Meet. Caribb. Food Crops Soc. (In press).