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INTEGRATED WEED CONTROL IN TRANSPLANTED TOMATOES

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ABSTRACT

Two field experiments on tomato, *Lycopersicon esculentus* Mill. var. Duke, were carried out in 1985. In the first experiment, the herbicides napropamide, bensulide and metribuzin were used either alone or in conjunction with manual weeding or mechanical cultivation. In addition, mechanical cultivation was also integrated with manual weeding. The highest marketable tomato yield was obtained with the hand-weeded control; other treatments where yields did not differ significantly ($P > 0.05$) from this were metribuzin (1.12 kg ai ha^{-1}) plus manual weeding; napropamide (4.48 kg ai. ha^{-1}) plus manual weeding; and a combination of mechanical, manual, and glyphosate treatments. All sole-herbicide treatments yielded significantly less than the hand-weeded control. In the second experiment, various mulchings with coffee leaves, sugar-cane trash, rice straw and plastic were used either alone or in conjunction with chemical or manual weeding. The highest marketable tomato yield was obtained with rice straw mulching plus manual weeding; sugar-cane trash mulching plus manual weeding; and plastic mulching plus manual weeding gave yields which were not significantly different from this. The treatments involving mulching plus manual weeding gave significantly better yields that those with mulching alone or mulching plus glyphosate.

RESUMEN

Dos experimentos de campo fueron llevados a cabo en el año 1985, utilizando el tomate, *Lycopersicon esculentum* Mill. var. Duke, como el cultivo experimental. En el primer experimento, los herbicidas, napropamide, bensulide y metribuzin, fueron utilizados, ya sea solos, o conjuntamente con el deshierbe manual, o con el cultivo mecánico. Adicionalmente el cultivo mecánico fué tambien integrado con el deshierbe manual. El rendimiento mas alto de tomate para mercadeo, fué obtenido mediante el control del deshierbe manual. Otros tratamientos en los cuales los rendimientos no difirieron significativamente, ($P > 0.05$) del mencionado anteriormente, fueron: metribuzin (1.12 kg ai. ha^{-1}) y el deshierbe manual; napropamide (4.48 kg ai. ha^{-1}) mas el deshierbe manual; y una combinacion de tratamientos mecánicos manuales y de glyphosate. Todos los tratamientos con herbicidas solamente rindieron significativamente menos que ésos con el control manual. En el segundo experimento, varias coberturas de hojas de cafe, hojarascas de caña de azucar, paja del arroz y láminas plásticas, fueron utilisadas ya sean solas o conjuntamente con el deshierbe químico o manual. El rendimiento mas alto de tomate para mercadeo, fué obtenido mediante el uso de la cobertura de paja de arroz en conjunción con el deshierbe manual. Los rendimientos obtenidos con el de hojarasca de caña de azucar en conjunción con el deshierbe manual y el de cobertura con láminas plasticas conjuntamente con el deshierbe manual, fueron muy diferentes al anteriormente mencionado. Los tratamientos involucrando cobertizos y deshierbe manual, dieron mejores rendimientos que aquellos con cobertizos solamente o los con cobertizos mas glyphosate.

Keywords: Tomatoes; Weed control; Mulching.

The use of black polyethylene plastic mulching for weed control in tomatoes was studied locally (Irizarry *et al*1968). This controlled practically all weeds, with the exception of purple nutsedge *(Cyperus rotundus* L.) but the high cost of plastic material had prevented its adoption for local use. With the introduction of low-cost plastic material in recent years, the use of plastic mulching for weed control in tomatoes and other vegetables has become practical. Burgis (1973a; 1973b) performed two tomato experiments integrating plastic mulching with herbicides (metribuzin and diphenamid) and obtained excellent weed control. In Nigeria, Quinn (1975) used natural materials such as corn cobs, nut shells and grass-straw integrated with hand weeding in tomatoes. The integrated treatments reduced the cost of weeding by 30 percent as compared to that of manual weeding.

A considerable amount of chemical weed control research has been done on tomatoes in Puerto Rico since 1978 (Almodóvar - Vega 1979-84; Jackson and Sierra-Morales, 1979). Consequently, local vegetable growers have relied heavily on herbicide usage and have not fully recognized the potentially harmful effects of herbicides on the environment. It is therefore deemed necessary to evaluate certain integrated forms of weed control as a means to optimize yield with minimal hazard to the environment.

The research reported in this paper was conducted to determine (1) the effects on tomato yield of chemical control alone and of its integration with manual weeding or mechanical control, and of the integration of mechanical control with manual weeding; (2) the effects on tomato yield of different forms of mulching alone or in combination with manual weeding or chemical control.

Materials and methods

Experiment no. 1

The experiment was conducted on a San Antón soil series (30 percent sand, 33 percent silt, 37 percent clay, 1.6 percent organic matter and pH 7.0) at the Fortuna Research and Development Center, Juana Díaz, Puerto Rico. The seed bed was prepared by ploughing followed by disc-harrowing in two directions. It was partitioned into 3.1 m x 3.7 m plots. Each plot consisted of 20 tomato plants arranged in two rows. The experimental layout was a randomized complete block with four replications. Tomato seedlings (var. Duke) were transplanted 20 December, 1984 when they were 28 days old. The drip irrigation system described by Goyal (1983) was used in this study. Napropamide at 4.48 kg ai ha^{-1}, bensulide at 2.34 l ha^{-1} and metribuzin at 1.12 kg ai ha^{-1} were

applied the day before transplanting. These herbicides were applied with a portable CO_2 sprayer calibrated to deliver a spray volume equivalent to 374 l ha^{-1} at a pressure of 2.1 kg cm^{-2} All herbicides were incorporated with a rake immediately after their application. The first mechanical weeding with a rototiller was performed 14 January, 1985, and a second on 4 February. Manual weeding by hoe was performed for the corresponding treatments on 9 and 14 January, 4 February and 3 and 21 March, 1985. All horticultural and pest-management practices were in accordance with the recommendations of the Conjunto Tecnológico para la Producción de Hortalizas (Estación Experimental Agrícola, 1976). Marketable fruits were harvested in four pickings at 14-day intervals.

Experiment no. 2

This experiment was also established on a San Anto series at Fortuna. The same plot size, experimental design, and tomato variety were used. The tomato cultivar Duke was transplanted to the field on the same day as experiment no 1. The plastic mulching was placed on the row before the transplanting. Within two weeks after transplanting, sufficient quantities of rice straw, sugar-cane trash and coffee leaves were placed to cover the ground. Herbicide treatment included the application of glyphosate by a side swipe (roller-wick applicator) on 14 January, 1985. The plots were hand weeded on 5 and 14 January, 2 and 22 February and 15 March for the corresponding treatments. All horticultural and pesticide treatments were similar to those of the first experiment and fruits were similarly harvested in four pickings.

Results and Discussion

Experiment no. 1

The highest marketable tomato yield (39,743 kg ha^{-1}) was obtained from the hand-weeded control treatment (Table 1). Other treatments where yields did not differ significantly ($P > 0.05$) from the hand-weeded control were: metribuzin (1.12 kg ai ha^{-1}) plus hand weeding; napropamide at 4.48 kg ai ha^{-1} plus hand weeding; a combination of mechanical plus manual plus glyphosate; mechanical cultivation (once or twice) plus hand weeding. All sole herbicide treatments, as well as those using herbicide plus mechanical cultivation, yielded significantly less than the hand-weeded control. The number of tomatoes produced from the different treatments followed approximately the same trend as production on a weight basis.

When the yield data were analyzed on a group basis, treatments involving hand-weeding yielded significantly higher than the group using herbicides alone (Table 2). The herbicide plus hand weeding group produced the highest tomato yields.

All integrated weed control treatments involving hand weeding produced high tomato yields. However, as hand weeding is an expensive operation, future trials should be aimed at the reduction of the frequency of hand weeding. Mechanical cultivation appears to be a logical choice in replacing or reducing expensive manual control. However, the cost and benefit aspects of hand weeding versus mechanical cultivation in an integrated weed control system need to be determined.

Experiment no. 2

The highest marketable tomato yield (47,255 kg ha^{-1}) was obtained from rice straw mulching plus hand weeding and in general, mulching in conjunction with manual weeding gave the best results (Table 3). Mulching alone with rice straw or sugar-cane leaves and sheaths also gave tomato yields which did not differ statistically ($P < 0.05$) from their integrated counterparts or the hand-weeded controls. However, tomato yield significantly decreased when mulchings (except with rice straw) were integrated with glyphosate treatment. The low yield could be attributed to the observed tomato injury resulting from glyphosate treatment. The number of tomatoes produced from the different treatments followed approximately the same descending rank as in the case of tomato weights.

When yield data were analyzed on a group basis, the mulching plus manual weeding group gave significantly higher yields than the mulching-alone and the mulching plus glyphosate groups (Table 4).

From the above results, it is evident that the best integrated weed control is achieved using mulches plus hand weeding. Further studies should be directed to determine the economic feasibility of those promising integrated weed control treatments. Special attention should be focused on the use of rice straw in the integrated weed control system since rice staw is a by-product of the island rice industry. It can be incorporated into soil whereas plastic mulching must be removed after harvest.

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Table 1 Effect of different herbicides alone or in combination with other non-chemical control methods on the marketable tomato yield

Treatment	Tomato production (ha) Weight (kg)	Number of fruits
Napropamide 4.48 kg ai/ha	26,013 c[u]	155,849 [u]e
Bensulide 2.34 l/ha	30,712 bc	179,843 cde
Metribuzin 1.12 kg ai/ha	32,230 bc	183,207 bcde
Napropamide + Mechanical cultivation (rototiller)	32,567 bc	189,934 bcde
Bensulide + Mechanical cultivation (rototiller)	30,018 bc	172,219 de
Metribuzin + Mechanical cultivation (rototiller)	34,442 b	199,577 abcd
Napropamide + Hand weeding	36,807 ab	209,667 abcd
Bensulide + Hand weeding	31,843 bc	193,522 bcde
Metribuzin + Hand weeding	39,447 a	221,552 ab
Mechanical cultivation (rototiller) once + Hand weeding	35,400 ab	216,395 abc
Mechanical cultivation (rototiller) twice + Hand weeding	35,635 ab	208,322 abcd
Mechanical cultivation (rototiller) twice + Hand weeding + glyphosate	36,532 ab	205,855 abcd
Mechanical cultivation only	30,518 bc	174,237 de
Hand-weeded check	39,743 a	236,352 a

[u] Means followed by the same letter or letters do not differ significantly at the 0.05 level of probability

Table 2 Effect of various types of weed control on tomato yield

Treatment	Tomato production (ha^{-1}) Weight (kg)	Number
Herbicides alone	29,651 c[u]	172,963 c[u]
Herbicides + Mechanical cultivation	32,342 abc	187,243 bc
Herbicides + Hand weeding	36,032 a	206,250 ab
Mechanical cultivation + Hand weeding	32,856 ab	210,188 ab

[u] Means followed by the same letter or letters do not differ significantly at 0.05 level of probability

Table 3 Effect of different mulchings alone or in combination with other weed control methods on the marketable tomato yield

Treatment	Tomato production (ha^{-1}) Weight (kg)	Number
Rice straw	44,594 ab	288,376 ab
Coffee leaves	29,304 cde	179,619 d
Sugar cane leaves and sheathes	36,173 abcd	228,055 bcd
Silver-coated black plastic + Hand weeding	44,727 ab	278,286 abc
Rice straw + Hand weeding	47,255 a	303,625 a
Coffee leaves + Hand weeding	41,496 ab	266,401 abc
Sugar cane leaves and sheathes + Hand weeding	45,186 ab	293,310 ab
Hand-weeded check (1)	39,641 abc	247,040 abc
Silver-coated black plastic + glyphosate (side swipe)	27,908 def	182,310 d
Rice straw + glyphosate (side swipe)	40,150 ab	251,601 abc
Coffee leaves + glyphosate (side swipe)	25,646 e	172,667 d
Sugar cane leaves and sheathes + glyphosate (side swipe)	34,452 bcde	214,825 cd
Hand-weeded check (2)	41,689 ab	251,825 abc

[u] Means followed by the same letter or letters do not differ significantly at the 0.05 level of probability

Table 4 Effect of various combinations of weed control methods on tomato yield

Treatment	Tomato production (ha^{-1}) Weight (kg)	Number
Mulching alone	36,746 bc[u]	227,724 b[u]
Mulching + hand weeding	44,666 a	285,408 a
Mulching + glyphosate	32,037 c	218,357 b

[u] Means followed by the same letter or letters do not differ significantly at 0.05 level of probality.