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WEED COMPETITION IN TRANSPLANTED TOMATOES

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ABSTRACT

Four field experiments were conducted in 1983 and 1984 at the Fortuna Research and Development Center, Juana Díaz, Puerto Rico, to determine the economic threshold of pigweed *(Amaranthus dubius)*, jungle rice *(Echinochloa colonum)* and horse purslane *(Trianthema portulacastrum)* and their critical period of competition in drip irrigated tomatoes *(Lycopersicon esculentum* Mill. var. Duke*)*. Tomato seedlings were 28 days old at transplanting. In the economic threshold study, weed populations were adjusted to 2, 5, 10, 20, 40 and 80 plants m^{-2}. In the critical period study, mixed weeds were allowed to compete for 0, 12, 24, 36, 48 or 60 days after transplanting and then were kept weed-free until harvest. The economic threshold was found to be 5 plants m^{-2} for pigweed; 40 plants m^{-2} for jungle rice; and 20 plants m^{-2} for horse purslane. This result suggests that pigweed would cause the greatest economic loss to vegetable growers. Pigweed was followed by horse purslane and jungle rice in descending order of causing economic losses. The critical period of weed competition was determined to be 0 to 36 days in 1983 and 0 to 48 days in 1984.

RESUMEN

Cuatro investigaciones del campo fueron conducidos en 1983 y 1984 en el Fortuna Research and Development Center, Juana Díaz, Puerto Rico, para determinar los niveles económicos de *Amaranthus dubius, Echinochloa colonum, Trianthema portulacastrum* y sus periods críticos de competicion en tomate *(Lycopersicon esculentum* Mill. 'Duke') regado por goteo. Al trasplantar, las plantas de tomate de semillero tenían 28 días de edad. En el estudio de niveles económicos, poblaciones de las malezas eran de 2, 5, 10, 20, 40 y 80 plantas m^{-2}. En el estudio de periodo crítico, mezclas de yerbas malas fueron permitidas competir por 0, 12, 24, 36, 48 o 60 días después de transplantar, y entonces, mantenido libre de yerbas malas hasta cosechar. Se encontró que el nivel económico era 5 plantas m^{-2} para *A. dubius;* 40 plantas m^{-2} para *E. colonum;* y 20 plantas m^{-2} para *T. portulacastrum.* El resultado sugiere que *A. dubius* causaría la major pérdida económica a cultivadores de hortalizas. *A. dubius* fue seguido por *T. portulacastrum* y entonces *E. colonum* en orden descendiente de causar pérdidas económicas. Se determinó que el periodo crítico de competición por malezas fue entre 0 y 36 días en 1983, y entre 0 y 48 días en 1984.

Keywords: Tomatoes; Weeds; Competition; Economic threshold; Critical period; Drip/trickle irrigation.

Tomatoes rank first among all vegetables of economic importance in Puerto Rico. According to 1982 Census of Agriculture (Anonymous, 1982) tomato growers contributed $3.5 million to the island economy. The unique mild weather of Puerto Rico enables us to produce a bumper crop of tomatoes during the winter season. Thus, tomato production in Puerto Rico has its great potential not only for self-sufficiency but also for exporting to the United States and Europe. One of the major factors limiting local tomato production has been the high cost of labor required to control weeds. Different weed control methods have been employed in attempts to reduce production costs. An integrated approach to weed control seems to be particularly attractive. Considerable baseline information has been accumulated with regard to the critical period of weed competion (Friesen, 1979; Weaver *et al*, 1983) and population densities effect of weeds on tomatoes yield (Monaco *et al*, 1981) in the United States and Canada. The above-mentioned research was conducted under climatic and edaphic conditions unlike those of Puerto Rico. It is highly imperative that information be gathered under local conditions in order to be valid.

Four field experiments on transplanted tomatoes were thus conducted at the Fortuna Research and Development Center during 1983 and 1984 to determine (1) the economic threshold of horse purslane, jungle rice and pigweed in tomatoes; and (2) the critical period of weed competition in the same crop. Information of this nature could be used as a guideline for establishing an integrated weed control program in tomatoes.

Materials and Methods

1983 Experiment

The experiment was conducted on a San Antón soil (30% sand, 33% silt, 37% clay, 1.6% organic matter; pH 7.0) at the Fortuna Research and Development Center, Juana Díaz, Puerto Rico which is located on the semiarid southern coast. The field was prepared by one plowing and two harrowings and partitioned into 3.3 m x 5.5 m plots. Each plot consisted of 30 tomato plants arranged in three rows. Plant spacing was 30 cm within the row. The layout of the experiment was a randomized complete block design with four replications. Twenty-eight-day-old tomato seedlings (var. 'Duke') were transplanted December 15, 1983, on the left side of a biwall drip line. The drip irrigation system described by Goyal (1983) was used in this study. The tomato plants received fertilizer (10-10-8) application at the rate of 1,198 kg ha^{-1} the second week after transplanting and a second one, at the same rate, at the initiation of flowering. Insects diseases and nematodes were controlled with recommended rates of oxamyl, methamidiphos, maneb, chlorothalonil, methomyl and diazinon during the course of the experiment (Acín *et al.* 1984). Marketable tomatoes were harvested in four pickings for all field experiments.

In the economic threshold experiment the same size of plot and experimental design as described previously was adopted. Individual weeds (horse purslane, jungle rice and pigweed) were adjusted to 2, 5, 10, 20, and 40 plants m^{-2} by hand within 21 days of transplanting. The different weed population densities were maintained until final harvest. In the

critical period , mixed weed populations were removed by hoe at 0, 12, 24, 36, 48 or 60 days after transplanting. The plots were kept weed-free thereafter. Tomato plants were staked and supported by nylon strings from the fourth week onward. All horticultural practices were in accordance with the recommendations developed by the Experiment Station (1976). The yield of marketable tomatoes from four pickings was recorded. Gross income was obtained by multiplying the total weight by a price of 73 cents kg^{-1}. The net income for different treatments was calculated by deducting the cost of production as described by Lloren *et al.* (1984).

1984 Experiment

The 1983 experiments were repeated on the same site during the winter of 1984. The same experimental design and planting distances were used, though an additional treatment of 80 plants m^{-2} density for the three weeds was added. The twenty-eight day old tomato seedlings (var. Duke) were transplanted 20 December, 1984. The same weed adjustment and removal methods were adopted as in the previous experiments. The tomato plants received one application of fertilizer, at the same rate as in 1983, in mid-February 1985. The pest control program was essentially the same as in the previous experiments. Marketable tomatoes were harvested four times. The gross income was calculated based on a price of 80 cents kg^{-1}. The net return of different treatments was calculated as in previous experiments.

Results and Discussion

Economic threshold study

Table 1 shows the net return of tomatoes derived from the different population densities of the three weeds. Statistical comparisons were made between individual weed densities and the control (0 plants m^{-2}) using Duncan's Multiple Range Test. The economic threshold of pigweed was 5 plants m^{-2} in both 1983 and 1984; that of jungle rice was over 40 plants m^{-2} in 1983, and 40 plants m^{-2} in 1984; that of horse purslane was not tested in 1983, and was 20 plants m^{-2} in 1984. According to Llorens *et al.* (1984), the cost for producing 'Duke' tomatoes in Puerto Rico amounted to an average of \$17,671 ha^{-1}. The results of the present study indicate that a pigweed density of 5 plants m^{-2} in 1983 and 20 plants m^{-2} in 1984 would leave farmers with no net return in tomatoes. However, the highest density of either jungle rice or horse purslane has not resulted in negative earnings. Thus, our findings suggest that pigweed would cause the greatest economic loss to growers. Pigweed was followed by horse purslane and jungle rice in descending order of economic importance. In the United States, Monaco (1981) reported that tomato yield was reduced by Jimson weed *(Datura stramonium)*, tall morning glory *(Ipomoea purpurea)* and common cocklebur *(Xanthium pensylvanicum)* at densities of 11, 43 and 86 m^{-2}. Other experiments found that tomato yield was reduced at densities even lower than those mentioned above. Large crabgrass *(Digitaria sanguinalis)* reduced tomato yield at densities of 55, 215 and 430 m^{-2} or somewhat lower. Since none of these weeds were studied in the present investigation, no valid comparison can be made.

Critical period of weed competition study

The predominant weed species in experimental plots listed in decreasing order of abundance were: pigweed *(Amaranthus dubius)*, horse purslane *(Trianthema portulacastrum)*, jungle rice *(Echinochloa colonum)*, goose grass *(Eleusine indica)*, crabgrass *(Digitaria sanguinalis)*, spider flower *(Cleome gynandra)* and Jimson weed *(Datura stramonium)*. Table 2 shows that tomato yield was significantly reduced after 36 days of weed competition in 1983. Weed competition was less severe in 1984 than in 1983. Tomato yield was significantly reduced after 48 days of competition with weeds. Friesen (1979) reported that tomato yield was significantly reduced if weeds were allowed to compete with the crop for more than 24 to 36 days after transplanting. Similarly, Weaver and Tan (1983) found that the critical period of weed competition in transplanted tomatoes was from 28 to 35 days. Both findings are in general agreement with our results of 1983. However, the result of 1984 indicates that weed interference in tomatoes could be extended to 48 days. The slightly lower maximum and minimum temperatures recorded in 1984 compared to 1983 might have caused weed growth to be less rapid thus necessitating a longer period of competition in order to affect tomato yield (Table 3). Since irrigation was used, tomato plants received sufficient water, so precipitation was probably not a factor which delayed the critical period of weed competition under the specific conditions of this experiment.

Table 1 The net return of tomatoes derived from different population densities of three weeds

Population density	Net return per hectare (dollars)					
	Horse purslane		Jungle rice		Pigweed	
(plants/m^2)	1983	1984	1983	1984	1983	1984
0 (control)	—[1]	14,651 a[2]	13,257 a	12,600 a	9,955 a	10,891 a
2	—	14,504 ab	12,437 a	9,915 ab	4,816 ab	10,159 a
5	—	11,266 ab	10,692 a	10,061 ab	−888 bc	2,835 b
10	—	10,843 ab	13,825 a	8,499 ab	1,783 bc	2,542 b
20	—	8,434 b	10,952 a	5,765 ab	−1,833 bc	−110 b
40	—	8,255 b	9,903 a	3,682 b	−5,409 c	−544 b
80	—	7,295 b	—	2,933 b	—	−1,396 b

[1] Horse purslane was not included in 1983 experiment because of the low infestation level of this weed.

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

Table 2 Effect of time of weed removal on yield of tomatoes grown on a San Antón soil

Duration of weed competition (days)	Yield of tomatoes (kg/ha) 1983	1984
0	35,526 a[1]	35,943 a
12	33,379 a	40,768 a
24	31,702 ab	39,222 a
36	22,163 bc	31,467 ab
48	12,260 cd	24,388 bc
60	10,670 cd	23,338 bc
All the time infested	6,298 d	15,599 a

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

Table 3 Maximum and minimum temperatures recorded at the Fortuna Research and Development Center during the 1983 and 1984 tomato growing seasons

Months	Average maximum temperature (°C) Experiment 1983	Experiment 1984	Average minimum temperature (°C) Experiment 1983	Experiment 1984
December	30.7	27.4	19.4	18.9
January	30.6	28.9	19.5	16.6
February	29.7	29.9	19.0	18.4
March	30.3	29.5	19.0	18.8
April	30.8	30.4	20.3	18.9
Average	30.4	29.2	19.4	18.3

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