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The effect of different irrigation systems on population dynamics of California red scale (Homoptera: Diaspididae) on lemon trees in Adana, Turkey

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Summary

The effect of four different irrigation medhods; drip, furrow, under-tree sprinkler, and overhead sprinkler, on population dynamics of California red scale (CRS), Aonidiella aurantii (Maskell) were studied on lemon trees in 1983 and 1984. CRS density was determined on three tissue substrates; leaves, twigs and fruit. The population density of CRS was always higher on fruit than other substrates. Density of CRS was always higher in overhead sprinkler irrigation plots on all substrates. Among the irrigation methods tested, furrow and drip irrigation seemed to be better practice to integrate for successful control of CRS, since the numbers of CRS were lower on all substrates in these two irrigation methods.

Introduction

The citrus industry of Turkey is rapidly expanding and becoming increasingly important for the economy of the country. In addition to rapid expansion, intensive research is being conducted to increase yield. Among the various cultural practices, irrigation is the most costly, repetitive and time consuming practice required to grow citrus in arid and semiarid climates (Marsh, 1973). Özsan et al. (1983) reported that average yield of young lemon trees were highest when irri-

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gated with overhead sprinkler system compared with furrow, drip, and under-tree sprinkler irrigation systems, but fruit quality was best with drip irrigation.

Some citrus pests act as limiting factors in citrus production in Turkey. California red scale (CRS), Aonidiella aurantii (Maskell), is the key citrus pest in inland areas of the eastern mediterranean region (Eronç, 1971; Uygun and Şekeroğlu, 1981, 1984; Uygun et al., 1987, 1988.

Our preliminary observations indicated differences in the population dynamics of CRS on lemon trees irrigated by different medhods. Therefore, the effects of four irrigation systems on development of CRS populations were investigated. Results of these studies are presented herein.

Material and Methods

Four study plots with furrow, drip, overhead sprinkler, and under-tree sprinkler irrigation were established in a 7 year-old lemon, Citrus limon (L.), grove, planted with 8 m by 4 m spacing , at the Universty of Çukurova Agricultural Research Farm, Adana, Turkey. Each study plot consisted of three rows of 46 trees running south to north.

Five trees from the center row of each plot were selected for study. Twenty leaves and six 10-cm long twigs, 6 to 7 mm in diameter, were sampled randomly around the periphery of each study tree and placed separately into polyethylene bags. Samples were brought immediately to the laboratory and all stages of CRS were counted under the stereomicroscope at 16X magnification. Five fruit from each study tree were sampled during the fruiting period. The entire surface area of the substrate (leaf, twig, or fruit) was examined for CRS. Samples were taken twice a month during the growing season and once a month during winter.

The study was conducted for 2 years beginning on 22 July 1983. No pesticides were applied in the study plots during the first year, but a single application of petroleum oil was made to all plots on 23 February 1984 to reduce CRS populations to more or less equal levels. For analysis total live scales were combined for each sampling date for each substrate, and transformed using Log (x+1) where x is the total number of live stages. Differences on scale density among the four irrigation methods were tested by subjecting the data to an analysis of variance (ANOVA), using completely randomized design (Sokal and Rohlf, 1981). We used the statistical package MSTAT (MSU 324 Agriculture Hall, East Lansing, MI 48824-1114) run on an IBM PC. Comparisions of means were made by Tukey's w-procedure at P = 0.05 (Sokal and Rohlf, 1981).

Results and Discussion

In general, the highest density of CRS was on fruit, followed in descending order by leaves, and twigs, in 1983, in all irrigation plots (Table 1). All tissue substrates in the plot with overhead sprinklers had numerically higher CRS density compared with the other irrigation methods. However, these differences were not significant among the irrigation methods for most of the sampling dates. This was probably the result of the high variability characterizing CRS densities among trees as indicated by the coefficient of variation (CV). The high CV indicated that CRS had uneven between-tree distribution. Only the CRS in the overhead sprinkler irrigation differed significantly from the other treatments, but this difference did not appear until late in 1983. If the total number of scales are summed for the year, CRS density was significantly greater in the trees exposed to overhead sprinklers (Table 1). CRS density on all substrates in each irrigation system was much lower in 1984 compared with 1983, but the general trends in population dynamics were similar to those obtained in 1983. Pooled data 1984 again indicated that CRS densities on all substrates were significantly higher in the overhead sprinkler treatment than in other irrigation systems (Table 2). However, few significant differences were observed within sampling dates, with furrow irrigation always showing lower CRS densities on all substrates (Table 2). CRS densities increased to their highest in the autumn both years, declining substantially during the winter.

The results obtained for both years indicated thad overhead sprinkler irrigation favored an increase in CRS density. McLaren (1971) found that low relative humidiy favored population growth CRS up to 30°C whereas high humidity enhanced population growth between 30°C and maximum thermal death point. Conversely, Atkinson (1977) reported that relative humidity had negligible effect on crawler production. Avidov (1970) and McLaren (1971) suggested that relative humidity affected crawler production, but this may be interpreted as an effect on crawler survival (Willard, 1973). These reports of the effect of relative humidity on CRS development and survivorship do not fully explain the different densities of CRS obtained in this study for different irrigation methods.

In any case, our results show that CRS population densities were always higher under overhead sprinkler irrigation than any of the other three irrigation systems. Until further data are acquired, furrow, drip, or under-tree sprinkler irrigation methods (preferably furrow, the most economic one) appear to provide for better control of CRS under local conditions.

Table 1 . Total mean number of all stages of CRS/substrate on lemon trees irrigated with different methots in 1983

Irrigation methods	22/7	4/8	19/8	5/9	21/9	7/10	22/10	23/11	24/12	31/1	Total
			Leaves								
Drip	13.8 A	7.8 B	13.6 B	19.4 A	13.0 B	30.4 A	8.0 A	15.6 C	13.4 AB	4.4 C	13.9 BC
Furrow	10.0 A	3.2 B	10.0 B	14.4 A	15.8 B	14.2 A	16.8 A	23.2 C	7.4 B	2.6 C	11.8 C
Under-tree	11.4 A	4.2 B	14.4 B	17.4 A	31.8 AB	24.2 A	21.6 A	32.8 B	15.8 A	7.2 B	18.1 B
Overhead	17.8 A	11.8 A	28.2 A	32.0 A	54.6 A	30.0 A	24.0 A	41.4 A	17.2 A	12.6 A	26.9 A
			Twigs								
Drip	0.8 A	4.0 A	0.4 B	1.8 B	3.2 B	1.4 A	4.2 A	0.8 B	5.8 A	0.0 B	2.2 B
Furrow	0.0 A	0.2 A	1.0 B	3.6 B	8.4 AB	1.8 A	1.8 A	0.4 B	4.0 A	0.8 B	2.2 B
Under-tree	0.6 A	2.4 A	4.2 AB	5.4 B	2.4 B	8.4 A	10.2 A	1.2 B	12.4 A	1.0 B	4.8 B
Overhead	0.4 A	8.8 A	10.0 A	14.6 A	14.6 A	8.0 A	25.8 A	6.4 A	11.8 A	11.2 A	11.2 A
			Fruit								
Drip		0.6 B	12.6 A	18.0 A	92.8 AB	61.0 B	53.2 A	112.2 BC	20.6 A	1.8 D	41.4 B
Furrow		0.8 B	6.2 A	13.8 A	55.0 B	83.0 B	67.8 A	57.4 C	20.4 A	4.4 C	34.3 B
Under-tree		0.6 B	35.2 A	54.2 A	62.2 B	91.0 B	71.4 A	174.0 B	19.8 A	9.8 B	57.B
Overhead		19.4 A	35.4 A	84.2 A	173.0 A	194.4 A	128.0 A	309.2 A	42.6 A	35.0 A	113.5 A

Means in a column followed by the same letter are not significantly different (P=0.05; Tukey's w test, Sokal and Rohlf, 1981).

Table 2 . Total mean number of all stages of CRS/substrate on lemon trees irrigated with different methots in 1984

Irrigation methods	23/2	31/3	2/5	10/6	9/7	24/7	6/8	20/8	3/9	18/9	1/10	8/10	16/10	30/10	Total
					Leaves										
Drip	2.2 B	0.0	0.0	0.8 A	0.6 B	2.0 B	1.8 B	2.8 B	6.4 A	5.4 A	6.4 A	3.6 A	4 A	4.6 B	3.7 B
Furrow	1.8 B	0.0	0.0	0.8 A	0.0 B	2.2 B	2.0 B	2.0 B	6.8 A	4.8 A	4.8 A	4.4 A	4.8 B	4.6 B	3.4 B
Under-tree	2.6 B	0.0	0.0	0.6 A	1.0 AB	5.8 AB	5.0 AB	3.0 B	9.2 A	6.2 A	6.2 A	5.8 A	6.4 A	7.2 AB	4.3 B
Overhead	7.0 A	0.0	0.0	1.6 A	2.0 A	9.2 A	8.0 A	8.8 A	10.8 A	8.4 A	10.2 A	9.2 A	7.8 A	10.0 A	6.4 A
					Twigs										
Drip	0.8 B	0.0	0.0	0.0	0.4 A	0.6 A	0.4 B	0.8 B	1.6 A	2.2	2.4 A	0.6 C	2.6 B	1.2 C	0.9 BC
Furrow	0.6 B	0.0	0.0	0.0	0.0 A	0.0 A	0.0 B	0.6 B	1.0 A	2.0 A	1.2 A	0.4 C	2.4 B	2.2 C	0.7 C
Under-tree	1.0 B	0.0	0.0	0.0	0.0 A	0.2 A	0.4 B	0.6 B	1.0 A	1.4 A	1.0 A	2.4 B	5.0 B	5.4 B	1.4 B
Overhead	3.4 A	0.0	0.0	0.0	0.4 A	1.0 A	1.6 A	2.4 A	1.6 A	4.0 A	3.6 A	5.0 B	8.6 A	8.8 A	2.9 A
					Fruit										
Drip	2.0	0.0	0.8 A	0.4 A	3.2 A	4.0 B	2.6 B	6.6 A	7.2 B	15.2 A	9.0 B	7.6 B	13.6 A	4.6 B	8.3 B
Furrow	1.6 B	0.0	0.2 A	1.0 A	4.6 A	4.6 B	2.0 B	6.0 A	7.0 B	13.8 A	9.0 B	10.8 AB	12.6 A	5.2 B	6.3 B
Under-tree	2.6 B	0.0	1.0 A	0.8 A	4.2 A	8.6 B	6.6 B	8.8 A	10.4 AB	14.4 A	10.8 B	11.0 AB	16.8 A	8.6 AB	6.6 B
Overhead	21.6 A	0.0	0.6 A	2.2 A	7.6 A	19.4 A	67.2 A	11.2 A	18.4 A	20.6 A	18.4 A	16.0 A	26.0 A	11.6 A	16.4 A

Means in a column followed by the same letter are not significantly different (P=0.05; Tukey's w test, Sokal and Rohlf, 1981).

Özet

Limon ağaçlarında Aonidiella aurantii (Homoptera : Diaspididae)'nin populasyon gelişmesine farklı sulama yöntemlerinin etkisi

Kırmızı kabuklu bitin populasyon gelişmesine dört farklı sulama yönteminin (damlama, karık, alttan yağmurlama, ve üstten yağmurlama) etkisi 1983 ve 1984 yıllarında araştırılarak, yaprak, sürgün ve meyve üzerinde Kırmızı kabuklu bit yoğunluğu belirlenmiştir. Kabuklu bit populasyon yoğunluğu meyve üzerinde ve sulama yöntemleri içinde de üstten yağmurlamada daha fazla olmuştur.

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