

Evaluation and Management of a 'Salina' Strawberry Clover Cover Crop in Citrus: First Year Preliminary Results¹

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Abstract

*Two orchard floor management strategies were evaluated beginning in the fall of 1997 in a 'Valencia' orange (*Citrus sinensis*) grove at the University of Arizona Citrus Agricultural Center (CAC) in Waddell, Arizona. The clean culture or bare ground treatment produced more yield than the 'Salina' strawberry clover treatment when harvested on March 10, 1999 and the tree canopy volume of the clean culture treatment was also greater than that of the clover treatment. Yield efficiency (lbs of fruit per cubic meter of canopy) was similar in the two treatments. The clean culture treatment produced more large size fruit (size 88 and larger) and less small size fruit (size 113 and smaller) than the strawberry clover treatment. Although the yield efficiency parameter suggests that it may be possible to produce as much fruit in the clover treatment as the clean culture treatment, the total yield and fruit size distribution of the clover treatment compared to the clean culture treatment were characteristic of the negative effects of competition from vegetation on the orchard floor found in other studies. Based on previous studies, competition for water was the most likely cause of the negative competitive effect. Installation of additional tensiometers to measure soil moisture at greater depths and leaf water potential measurements to assess the degree of water stress in both treatments prior to irrigation will hopefully allow further improvement in irrigation scheduling to eliminate the negative affect of having vegetation on the orchard floor in the clover plots.*

Introduction

Recently there has been renewed interest in using cover crops in Arizona citrus groves. The advantages frequently attributed to cover crops may include weed suppression, an increased complement of beneficial microorganisms in the soil, decreased soil compaction, increased water infiltration, and improved root growth due to increased soil organic matter. Increasing soil organic matter content may potentially improve nutrient availability to plants by increasing both the cation exchange capacity and buffering capacity of the soil. Irrigated cover crops are known to decrease soil and canopy temperatures and have the potential to harbor beneficial predatory insects. Legume species that can be adapted to citrus production practices appear to have greater potential benefits than covers of non-legume

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broadleaf and grass species or resident weed species because legumes add nitrogen to the soil. This legume-derived nitrogen may increase the nitrogen available for fruit production and decrease the requirement for nitrogen fertilizer inputs. Non-legume species and resident weeds will consume nitrogen and other nutrients as well as water. Potential disadvantages of using cover crops in citrus orchards include unfavorable increases in insect (*e.g.*, thrips, whiteflies, and aphids) and nematode populations, difficulty in irrigating the citrus and cover crops in flood irrigated systems, reduced crop yields and increased risk of frost damage in due to orchard cooling.

Previous research at the University of Arizona Citrus Agricultural Center (CAC) in Waddell, Arizona concluded that of the legume cover crops evaluated 'Salina' strawberry clover was one of the best suited for use as a cover crop in Arizona citrus groves (McCloskey *et al.*, 1995). A study was established at the CAC in the fall of 1993 in a Valencia orange grove to compare three treatments: (1) 'Salina' strawberry clover on the orchard floor middles, (2) mechanically mowed resident weed populations on the orchard floor middles, and (3) clean culture with no vegetation on the orchard floor (bare ground). At the 1995-6 harvest, it was found that the clean culture treatment had the highest yield (114 ± 38 lbs/tree) compared to the Strawberry clover (97 ± 41 lbs/tree) and mowed resident weed treatment (88 ± 24 lbs/tree) (McCloskey *et al.*, 1996, 1997). The significant yield reduction in the mowed resident weed treatment at the CAC was similar to yield reductions measured in mowed resident weed plots in an orchard floor management experiment conducted in a 'Limoneira 8A Lisbon' lemon (*C. limon*) orchard on the Yuma Mesa. Thus, it was concluded that mowing resident weedy vegetation is not a viable orchard floor management option in Arizona. Although there was a yield reduction in the 'Salina' strawberry clover treatment, it was found that the clover did significantly increase the amount of soil nitrogen and organic matter (Table 1) and did not affect the nutrient status of the trees with respect to nitrogen, potassium, phosphorus and sulfur compared to the bare ground treatment (McCloskey *et al.*, 1997). The fact the orchard floor treatments were irrigated at the same time with the same amounts of water suggested that competition for water between the strawberry clover and oranges caused the reduced orange yields and that this yield penalty could possibly be avoided by measuring soil moisture and improving irrigation scheduling. Thus, the objectives of this project were to measure soil moisture status and improve irrigation scheduling by differentially irrigating the strawberry clover plots and bare ground plots, and to determine the effect of the two orchard floor management strategies on Valencia orange trees.

Materials and Methods

This experiment compared clean culture (*i.e.*, no weeds) with a 'Salina' strawberry clover cover crop and was a modification of a previous experiment that was established in the fall of 1993 in a Valencia orange grove that was planted on a row and tree spacing of 22' x 22' on 5/5/90 at the U of A CAC (McCloskey *et al.*, 1997). The trees were reassigned to treatments using a randomized complete block design with two treatments and four blocks in the fall of 1997. Where appropriate, resident weeds were sprayed with Roundup herbicide and 'Salina' strawberry clover was planted. It took most of the spring and early summer to reestablish the plots. Guard row trees (*i.e.*, trees not included in any treatment) surround the experiment and separate each block from other blocks. Each plot consisted of 15 trees arranged in a 5 tree by 3 tree square. The strawberry clover occupies the entire area between adjacent tree canopies. The clean culture treatment was maintained using hand cultivation and spot treatments with Roundup. Tensiometers were installed at several locations in each plot at two depths, 1 and 2 feet deep, at the edge of tree canopies to measure soil water and irrigate on demand. Water was applied to the orchard using flood irrigation and a system of dikes that separated the bare ground and clover plots and allowed differential irrigation. The treatments were harvested on 3/10/99 and the fruit were weighed and sized. The canopy volume of each harvested tree was calculated from the size and shape of the tree canopy and yield efficiency (lbs of fruit/m³) was determined.

Results and Discussion

The clean culture or bare ground treatment produced more yield than the 'Salina' strawberry clover treatment when harvested on March 10, 1999 (Table 2). The canopy volume of the clean culture treatment was also greater than that of the clover treatment (Table 2). There are at least two possible explanations for the difference in canopy volume; (1) the difference was coincidental due to the residual effects of frost damage that occurred in 1990, or (2) the smaller tree canopy volumes in the clover plots were due to long-term competition between many of the trees in

these plots and the clover. Yield efficiency (lbs of fruit per cubic meter of canopy) was similar in the two treatments (Table 2). The clean culture treatment produced more large size fruit (size 88 and larger) and less small size fruit (size 113 and smaller) than the strawberry clover treatment (Table 3). Although the yield efficiency parameter suggests that it may be possible to produce as much fruit in the clover treatment as the clean culture treatment, the total yield and fruit size distribution of the clover treatment compared to the clean culture treatment were characteristic of the negative effects of competition from vegetation on the orchard floor (McCloskey *et al.*, 1997). Based on previous studies, competition for water was the most likely cause of the negative competitive effect. Thus, we are probably not adequately monitoring soil moisture and are not applying enough water to the clover plots to compensate for water use by the clover. We are currently in the process of installing additional tensiometers to measure soil moisture at greater depths and will make leaf water potential measurements to assess the degree of water stress in both treatments prior to irrigation. Hopefully, we can further improve irrigation scheduling to eliminate the negative affect of having vegetation on the orchard floor in the clover plots.

References

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Table 1. Effect of the clean culture, mowed resident weeds, and ‘Salina’ strawberry clover orchard floor vegetation management treatments on total soil nitrogen, total soil organic carbon, and total soil organic matter in Valencia oranges at the Citrus Agricultural Center in Waddell. Values are means \pm standard deviation; values within a column followed by the same letter are not significantly different according to Tukey-Kramer Honestly Significant Difference test at P=0.05.

Treatment	Total soil nitrogen (ppm)	Total organic carbon (% w/w)	total organic matter (% w/w)
Clean culture	367 \pm 65 b	0.247 \pm 0.035 c	0.493 \pm 0.069 c
Resident weeds	433 \pm 65 b	0.345 \pm 0.042 b	0.690 \pm 0.084 b
Strawberry clover	567 \pm 98 a	0.452 \pm 0.089 a	0.903 \pm 0.174 a

Table 2. Effect of a ‘Salina’ strawberry clover cover crop and clean culture treatments on Valencia orange tree canopy volume, yield and yield efficiency at the March 1999 harvest. Values are means \pm standard deviation; values within a column followed by the same letter are not significantly different at P=0.05 according to Analysis of Variance and Least Significant Difference.

Treatment	Canopy volume (m ³)	Total yield (lbs/tree)	Yield efficiency (lbs/m ³)
Clean culture	30.5 \pm 6.4 a	214 \pm 51 a	7.4 \pm 2.8 a
Strawberry clover	25.9 \pm 8.2 b	174 \pm 49 b	7.7 \pm 4.0 a

Table 3. Effect of a ‘Salina’ strawberry clover cover crop and clean culture treatments on Valencia orange fruit size (fruit/box) as a percentage of all fruit harvested on March 10, 1999. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Analysis of Variance and Least Significant Difference.

Treatment	Fruit size (fruit/box) as a percentage of all fruit harvested						
	138 or smaller %	113 %	88 %	72 %	56 %	48 %	40 or larger %
Clean culture	4.5 \pm 3.3 b	34 \pm 10 b	35 \pm 6 a	16.5 \pm 5.4 a	5.8 \pm 4.1 a	1.8 \pm 2.1 a	2.0 \pm 3.6 a
Strawberry clover	9.8 \pm 7.0 a	47 \pm 9 a	31 \pm 8 b	8.4 \pm 4.5 a	2.3 \pm 1.9 b	0.5 \pm 0.7 b	1.0 \pm 2.6 a