AN ORGANIC VERSUS A CONVENTIONAL FARMING SYSTEM IN KIWIFRUIT

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Abstract

To determine the feasibility of growing kiwifruit organically, a kiwifruit vineyard converted to an organic farm was compared to a conventionally farmed vineyard from 1990 through 1992. January or March applications of composted chicken manure (organic system) or NH_4NO_3 plus $CaNH_4(NO_3)_3$ through micro sprinklers during the growing season (conventional system) were applied to give nearly equal rates of 168 kg N ha^{-1}. Soil analysis showed a trend toward a higher pH and organic matter over time for the organic system. In 1992, there was a trend for the organic system to have higher NH_4-N and lower NO_3-N concentration in the soil. Leaf nitrogen levels from the organic system were consistently lower than those from the conventional system but were not deficient. Leaf concentrations of sodium and chloride increased over the three-year period in the organic system but not to phytotoxic levels. Leaf zinc levels were adequate and increased over time in both systems. Organically grown fruit was as firm as or firmer than conventionally grown fruit at harvest and four months after harvest. No differences were seen in percent soluble solids content. Damage from latania scale and omnivorous leaf roller was small in both systems except scale damage in the organic system in 1992. An economic analysis of the cultural practices showed that the organic system cost almost $720 per ha more then the conventional system. The grower reported fewer repack losses for organically grown fruit in 1992. We conclude that growing kiwifruit organically is feasible if an economic premium is received.

1. Introduction

Kiwifruit culture in California lends itself toward organic production. Typically, there are few insects or diseases that cause major problems, weeds are shaded from growing under mature full canopied vineyards, and nutrient removal by the crop is minimal (Smith *et al.,* 1987, Sale, 1987). Some of the most effective insecticides are also acceptable to regulators of organically grown produce.

A kiwifruit vineyard converted to an organic farm was compared to a conventionally farmed vineyard from 1990 through 1992 to determine the feasibility of growing kiwifruit organically in California.

2. Material and methods

A 1.2 ha kiwifruit block (planted in 1983) converted to an organic farming system in 1990 was compared to a conventionally maintained 1.2 ha block (planted in 1980). The blocks were of similar location, yield, training system and soil type (Ramada loamy sand and fine sandy loam series) and managed by the same grower. Both blocks consistently yielded more than 39 t/ha. The cultural practices that differed between the two systems were fertilization, insect control and weed control.

2.1. Cultural practices

2.1. 1. Fertilization

Manure and inorganic fertilizer were added to give nearly equal rates of actual nitrogen (l68 kg ha^{-1}). Composted chicken manure (2.3-2.5% N, 2.7-2.8% P, 3.1% K) at 5600 to 6725 kg ha^{-1} was spread under the vines and lightly incorporated in March 1990, January 1991, and 1992 in the organic system. In the conventional system, NH_4NO_3 was applied to the soil surface in February and $CaNH_4(NO_3)_3$ was applied through microsprinklers from mid-May through July. K_2SO_4 was applied to the soil surface at 224 kg ha^{-1} in February 1990 and 1991 and in April 1992.

2.1.2. Insect control

No insecticides were applied to either system in 1990. Volck Supreme Spray Oil was applied to both systems during the dormant season for scale control in 1991. Cryolite 96 Natural was used to control Onmivorous leaf rollers during the summer in the organic system. During the summer of 1992, Cryolite 96 Natural and Phosmet were sprayed to control omnivorous leaf rollers in the organic and conventional system respectively.

2.1.3. Weed control

Only mowing and hand hoes were used to control weeds in the organic system. The contact herbicides Paraquat dichloride and glyphosate were used around the vines and the row middles were mowed in the conventional system.

2.2. Sampling procedure

2.2.1. Water samples

Water samples were taken in 1990 from the irrigation source, which was the Yuba River. Analyses included EC, NH_4-N and NO_3-N.

2.2.2. Leaf and petiole samples

Within each of four locations per system, 30 leaf and petiole samples were taken from nine vines in July of 1990-92. Analyses included N, P, K, Mg, Na, Cl, Zn, and Mn.

2.2.3. Soil samples

Within each of four locations per system, 12 soil cores were taken at 0-15 cm, 15-30 cm and 30-45 cm. Twelve soil cores were taken at each depth approximately .61 meters from the base of vines. The cores were combined at each depth. In 1992, the top 5 cm were removed from the 0-15 cm cores to avoid contamination from manure residues. Analyses included pH, EC, NH_4-N, NO_3-N, N, P, K and OM. Samples were taken in March, May and June in 1990, 1991 and 1992 respectively.

2.2.4. Insect infestation samples

A survey was conducted at the onset of the study for the presence of scale and parasites and predators of scale in both systems. The two systems were monitored by a pest control advisor who determined the need to spray. At harvest, 250 fruits per location (total 1000 fruits) for each system were examined for the presence of scale and omnivorous leaf roller damage.

2.2.5. Post harvest fruit quality

At harvest, within four locations of each system, 70 fruits were randomly picked. Of that, 30 fruits were packed into a flat and kept in cold storage for testing four months later; 25 fruits were taken for immediately testing. Each fruit was tested on two sides for kgf using a U.C. pressure tester. A slice was taken from each fruit amd combined for percent soluble solids for each location. Percent ripened soluble solids were measured in 1990 and 1992. The tests were repeated four months after harvest.

2.3. Economic analysis

Complete records were kept on all cultural and harvest operations and selling price for each system. In 1992, when the grower was first allowed to sell his fruit as certified organic, an economic analysis comparing cultural operations and selling price was performed between the two systems.

3. Results

3. 1. Water analysis

The EC was 0.10 d S m^{-1}. Essentially no nitrogen was present in the irrigation water (<0.1 ppm NH_4-N and <0.1 ppm NO_3-N).

3.2. Leaf and petiole analysis

Leaf concentrations of nitrogen were consistently lower in the organic system than those from the conventional system but not deficient (table 1). All nutrient levels were above known critical levels for both systems. Leaf concentrations of sodium and chloride increased over time in the organic system but did not reach phytotoxic levels.

3.3. Soil Analysis

A trend was observed for a higher pH at all soil depths in the organic system versus the conventional system over time (table 2). There was also a trend for the organic matter to increase over time in the top 30cm of the organic system. In 1992, there was a trend for the organic system to have a higher NH_4-N and lower NO_3-N concentration than for the conventional system.

3.4. Insect damage

In 1990, the organic system had 1.8% omnivorous leaf roller damage and the conventional system had 0.5% damage. The organic and conventional systems respectively had 1.0% and 0.8% omnivorous leaf roller damage in 1991; Latania scale infestation was 0.1% and 0.2% in the organic and conventional systems respectively. Omnivorous leaf roller damage was 0.6% and 0.0% in the organic and conventional systems respectively in 1992; there was 0.0% Latania scale in the conventional system and 3.9% Latania scale infestation in the organic system.

3.5. Post harvest fruit quality

Fruit from the organic system was consistently as firm as or firmer than conventionally grown fruit at harvest and four months after harvest (table 3). Generally, there was little variation in percent soluble solids between the two systems at both testing times.

3.6. Economic analysis

Costs are listed on a per hectare basis in US dollars and pertain only to the 1992 crop. Pest management costs were \$141 and \$200 for the organic and conventional systems respectively. Fertilizer costs were \$620 in the organic system as compared to \$389 in the conventional system. Weed control costs were \$519 and \$388 in the organic and conventional systems respectively. Assessments on organically grown fruit were \$482. Other cultural costs were very similar - \$4759 in the organic system and \$4930 in the conventional system. Harvest costs were more in the organic system due to a larger yield, \$1264 versus \$1159. Total cultural and harvest costs were \$7785 and \$7066 for the organic and conventional systems respectively. Gross revenue return per tray equivalent was \$4.60 for organically grown fruit and \$3.60 for conventionally grown fruit. Total average repack losses reported by the grower were 2.15% and 5.69% for fruit from the organic and conventional systems respectively.

4. Discussion

In the organic system where composted chicken manure was applied, a lower nitrogen release rate was thought to be responsible for lower nitrogen in the leaf tissue. There was a trend toward increased phosphorus and zinc content and a lower manganese content in the leaf tissue but all were above known critical levels. No differences were observed in other nutrient levels. Kiwifruit growers often sustain high repack costs when fruit is held for many months in cold storage. Previous work (Prasad and Spiers, 1991) has suggested that over fertilization with nitrogen can cause rapid softening of fruit in storage. Leaf nitrogen levels from the organic system were consistently lower than those from the conventional system but not deficient. Organically grown fruit was as firm as or firmer than conventionally grown fruit at harvest and four months after harvest. Grower repack losses were less in the 1992 crop year for organically grown fruit than for conventionally grown fruit. Further studies are needed to determine if the firmer fruit in the organic plot is due to the nitrogen source applied which results in lower leaf nitrogen levels or some other factor. Replicated trials comparing fruit quality from treatments with manure and inorganic nitrogen sources are planned.

Leaf concentrations of sodium increased over the three-year period in the organic plot. Chloride levels were also higher in the organic system but not to phytotoxic levels. The rainfall where the vineyard is was 43cm, 48cm and 52cm for the 1990 through 1992 seasons respectively so adequate leaching of salts may not have occurred. This potential salt accumulation would need to be monitored and sufficient irrigation water applied to leach salts from the root zone if necessary.

Soil was sampled at 0-15, 15-30 and 30-45cm depth. The higher test results for the organic system in 1991 were apparently due to residual manure that was not incorporated. In 1992, the manure residue was removed prior to taking soil samples and test results were similar for the two systems. There is a trend toward a higher pH over time in the organic system for all soil depths and a higher organic matter content in the 0-15 and 15-30cm depths. The trend for slightly lower soil pH in the conventional system may explain the trend for slightly higher leaf Mn levels. In 1992, there was a trend for higher NH_4-N and lower NO_3-N concentrations in the organic than in the conventional system. This trend has been observed in other organic/conventional comparisons (Vossen *et al.,* 1994).

There were few differences in insect damage between the two systems. This is expected since the organically acceptable pesticides are effective (Hasey *et al.,* 1994). It is difficult to explain the higher amount of scale in the organic system in 1992, particularly since neither system received a dormant spray. A survey for scale and parasites at the onset of the study revealed that none were present in either system.

From our economic comparison, it cost more to grow kiwifruit organically, with fertilizer and weed control the main differences in cultural costs. Receiving a higher price is common for organically grown fruit (for 1992, the grower received $1.00 more per tray). During 1992, growing kiwifruit organically was economically feasible because of lower repack losses and higher prices received.

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Table I - Organic (org) versus conventional (conv) leaf and petiole analysis.

Treatment	N	P	K	Na	Cl	Mg	Mn	Zn
	---	---	---	%	---	---	mg kg^{-1}	---
1990								
Org	2.13	.17	1.68	.018	.43	.80	90.8	24.8
Conv	2.68	.16	1.87	.016	.43	.72	136.8	23.6
1991								
Org	2.23	.17	1.32	.020	.44	.70	151.0	29.3
Conv	2.70	.13	1.33	.010	.39	.77	162.0	27.8
1992								
Org	2.16	.20	1.97	.066	.78	.67	122.0	30.3
Conv	2.63	.10	1.89	.009	.60	.71	172.3	26.8

Table 2 - Organic (org) versus conventional (conv) soil analysis.

Treatment	pH	EC	NH_4-N	NO_3-N	HCO_3-P	Exch-K	OM
		dSm^{-1}	--- --- --- ---	--- --- mg kg^{-1}	--- --- ---	--- --- --- ---	(%)
1990 (0-l5cm)							
Org	6.9	0.44	2	3	13	225	1.13
Conv	6.7	0.62	2	11	14	142	1.33
1991 (0-l5cm)							
Org	6.9	1.34	4	52	12	419	1.78
Conv	6.5	0.46	3	11	5	145	1.21
1992 (0-l5cm)							
Org	7.3	0.45	15	12	10	212	1.85
Conv	6.3	0.70	6	20	4	142	1.38
1990 (15-30cm)							
Org	6.9	0.38	2	2	7	153	0.63
Conv	6.5	0.46	2	4	7	107	0.62
1991 (15-30cm)							
Org	6.9	0.50	2	12	5	296	0.70
Conv	6.2	0.25	2	5	5	117	0.45
1992 (15-30cm)							
Org	7.2	0.25	5	6	4	187	0.75
Conv	6.1	0.40	4	10	3	152	0.60
1990 (30-45cm)							
Org	6.9	0.47	2	1	5	103	0.36
Conv	6.5	0.41	2	3	4	119	0.50
1991 (30-45cm)							
Org	6.9	0.34	1	8	3	152	0.38
Conv	6.3	0.25	3	4	3	137	0.31
1992 (30-45cm)							
Org	7.1	0.20	5	4	3	139	0.46
Conv	6.1	0.55	3	13	2	165	0.50

Table 3 - Organic (org) versus conventional (conv) fruit quality.

	SS,%		Firmness(kgf)		Ripened SS,%	
Treatment	Org	Conv	Org	Conv	Org	Conv
1990 Harvest	7.2	7.2	6.7	6.0	15.5	14.5
4 mo. Storage	13.3	13.0	2.9	1.8		
1991 Harvest	7.4	7.9	6.0	5.6		
4mo. Storage	13.8	13.3	1.8	1.5		
1992 Harvest	7.8	7.8	6.6	6.6	15.1	15.5
4mo. Storage	14.8	13.9	1.7	1.3		