CARBON STORAGE IN KIWIFRUIT ORCHARDS OF NEW ZEALAND BASED ON ABOVE AND BELOW-GROUND BIOMASS

Rahman H.[1], Holmes A.[1], Saunders S.[1], Deurer M.[2], Clothier B.[2] and Mowat A.[3]
[1] PlusGroup Ltd., Newnham Park, Te Puna, Tauranga, New Zealand
[2] The Plant and Food Research Institute of New Zealand Limited., Production Footprint Team, Batchelar Road, Palmerston North, New Zealand
[3] ZESPRI International Ltd., 400 Mt Maunganui Road, New Zealand
Corresponding author's e-mail: technical@plusgroup.co.nz

Background

1. Terrestrial carbon balance is influenced by soil, climate, vegetation and management.
2. Vegetative growth of kiwifruit vines in New Zealand is vigorous due to warm and moist climatic conditions.
3. The impact of kiwifruit production on greenhouse gas emissions was estimated in New Zealand with a life-cycle assessment based carbon footprint analysis using the PAS2050 framework.
4. This framework does not consider the soil or the kiwifruit vines as a source or sink of atmospheric CO2.

Objectives

1. Measure carbon storage in above- and below-ground parts of kiwifruit grown using different management systems.
2. Estimate the contribution of different variables to the total carbon pool in kiwifruit orchards.
3. Compare the spatial variability of carbon in kiwifruit soils.
4. Evaluate the possible benefits of different kiwifruit management practices on the carbon pool of kiwifruit.

Materials and Methods

The experiment was conducted in 2008 with organic, biological, and conventional kiwifruit management systems in each of three agro-ecological zones: Katikati, Tauranga and Te Puke, as shown below.

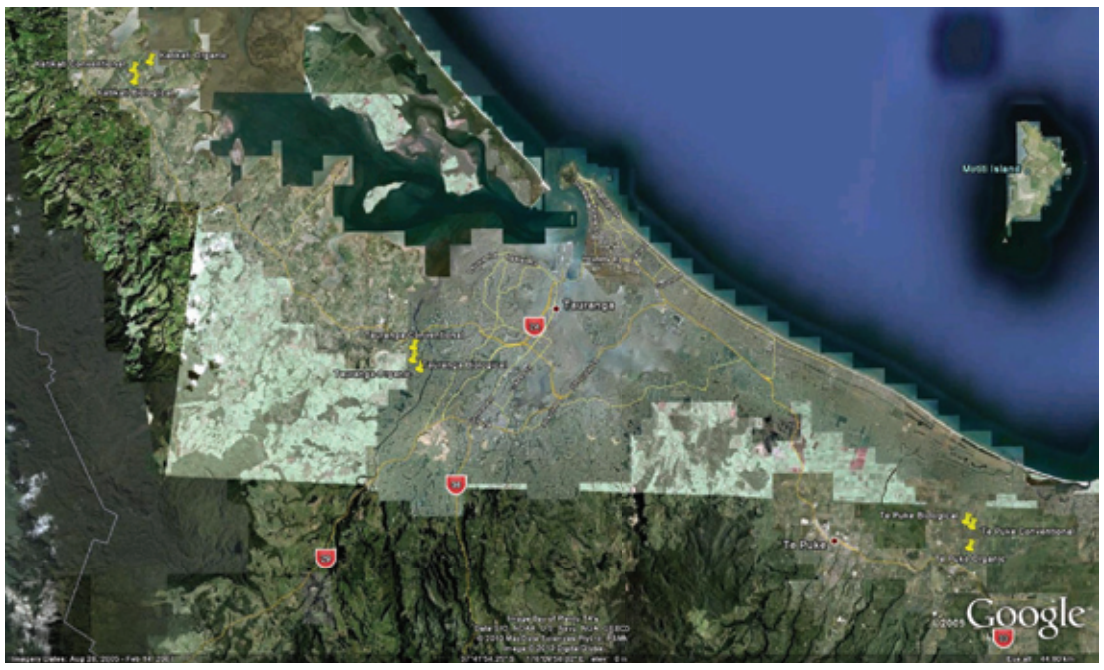

Fig. 1. Location and distribution of the nine sampled orchards

The soil of all the experimental sites is typical orthic allophanic with sandy loam texture.

The above-ground bio-mass was measured as standing stable dry matter (kiwifruit vines) plus litter dry matter (vine prunings, leaves and grasses).

Kiwifruit vine (trunk, leader, cane and new growth) length, diameter and dry matter was measured.

Fig. 2. Sampling position of vine, litter and roots

Three sampling plots (bays) of 5m x 4m were randomly selected at each site from between the plants along the row (plant row);

in the middle of the sward between the rows (grass alleyway) and from the area that machinery travels along between the rows (wheel tracks).

Ground litter and soil was collected using a 25 x 25 cm square at 0-5 cm, 5-10 cm and 10-15 cm depth. The below-ground biomass of secondary

and tertiary kiwifruit roots and sward roots was extracted from soils. Undisturbed soil samples were collected using a Daiki Soil Sampler with a 100cc core, and soil bulk density was measured.

Fig. 3. Sampling position of soil and root biomass

Above- and below- ground biomass carbon content was measured by loss-on-ignition (LOI) of ground samples at 500oC for 6 hours.

Soil organic carbon was measured using three recognised methods: wet chemistry, dry chemistry (LECO) and loss-on-ignition for the 81 soil samples.

LOI was used as it is a popular, rapid, easy and inexpensive method. Based on the results, a regional regression equation was developed to estimate SOC from LOI

using different heating temperatures and durations. Carbon sequestration in each layer of soil was calculated and the carbon storage in kiwifruit orchard was esti-mated.

Results are presented irrespective of depth and position.

Results

Table 1. Above- and below- ground biomass in kiwifruit orchards of New Zealand

Factor	Biomass dry matter (t ha $^{-1}$)			
	Vines	Litter	Roots	Total
Organic	18.04	9.52	1.08	28.64
Biological	17.31	9.42	1.22	27.95
Conventional	17.20	7.76	1.01	25.97
Katikati	13.28	8.00	0.61	21.88
Tauranga	20.33	9.91	1.12	31.37
Te Puke	18.94	8.62	0.57	28.13

Table 2. Total carbon (t ha-1) in kiwifruit orchards of New Zealand

Factor	Vines	Litter	Roots	Soil	Total
Organic	10.03	5.04	0.29	51.68	67.02
Biological	9.61	5.09	0.36	51.76	66.94
Conventional	9.55	4.15	0.32	49.68	54.66
Katikati	7.40	4.29	0.19	42.68	54.66
Tauranga	11.27	5.28	0.33	50.03	66.95
Te Puke	10.51	4.61	0.13	41.52	56.96

Table 3. Contribution (%) of different variables to carbon storage in kiwifruit orchards

Factor	Vines	Litter	Roots	Soil
Organic	14.96	7.52	0.43	77.12
Biological	14.35	7.61	0.54	77.33
Conventional	14.95	6.49	0.51	77.57
Katikati	13.54	7.85	0.35	78.07
Tauranga	16.84	7.89	0.50	74.73
Te Puke	18.46	8.09	0.22	72.89

Summary

1. The highest biomass was recorded in the Tauranga zone with organic management.
2. Vine carbon was 10.03 t ha-1 for organic, 9.61 t ha-1 for biological and 9.55 t ha-1 for conventional systems.
3. Below-ground had higher carbon storage than above-ground with the ratio (below-ground: above-ground) of 3.45 for organic, 3.55 for biological and 3.63 for conventional management systems; and 3.67 for Katikati, 3.05 for Tauranga, and 2.77 for Te Puke zones.
4. The total carbon storage in kiwifruit orchards of New Zealand varied with agro- ecological zones, with 54.66 t ha-1 in Katikati; 66.95 t ha-1 in Tauranga and 56.96 t ha-1 in Te Puke.
5. Regardless of management and zone, the total carbon storage was more than 50 t ha-1 in kiwifruits orchards in NZ.
6. Soil contributed more to carbon storage than vines, litter and roots.

Conclusions

Soil contributes more than other variables to carbon storage in kiwifruit orchards.

The differences in carbon sequestration between different management systems and agro-ecological zones indicate the necessity of estimating carbon emissions due to anthropogenic activities to allow us to identify management practices that best protect and enhance carbon in kiwifruit orchards, and to predict the contribution of kiwifruit production to the global carbon cycle.

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Plus Group Horticulture Ltd
Newnham Park, Te Puna, Tauranga, New Zealand