# Storage Potential of Kiwifruit from Alternative Production Systems

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# Abstract

The effects of nine soil treatments on the storage potential of 'Hayward' kiwifruit were examined over three consecutive seasons at sites in Palmerston North and Te Puke, New Zealand (NZ). The treatments comprised three ground covers (*viz.* bare, grass and mulch), in factorial combination with three fertiliser regimes (*viz.* conventional, organic and organic plus (= organic + gypsum)). Each season, several fruit and vine attributes were measured at harvest and the subsequent softening behaviour of fruit was evaluated during storage. In the second and third seasons, several soil, fruit and vine attributes were also monitored before harvest. At both sites, significant and consistent differences were observed in many of the soil attributes that were measured. In particular, conventional plots often contained more inorganic nitrogen (N) and potassium (K) than organic and organic plus plots while organic plus plots nearly always contained more calcium (Ca) than conventional plots. Bare soil consistently contained less moisture, and experienced higher 2.00 pm and lower 6.00 am temperatures, than covered soil, while the mulch increased the surface rooting of vines. The soil amendments also had some consistent, though not statistically significant, effects on the mineral composition of vines, especially in the third season. In particular, fruit and leaves from conventional plots tended to contain more N and K but less Ca than those from organic and organic plus plots while fruit and leaves from grass plots consistently contained less N than those from bare and mulch plots. Of all the soil amendments, grass had the largest effect on fruit storage behaviour i.e. fruit associated with that amendment were consistently firmer throughout storage and developed significantly less soft patches than fruit from bare and mulch plots. Although fruit from conventional plots tended to soften slightly more rapidly and develop more soft patches than fruit from organic and organic plus plots, the differences were never significant. Generally, soil, vine and fruit attributes did not differ significantly with the interaction of ground cover and fertiliser regime.

In addition to the above work, in 1996 only, fruit were sampled from ten pairs of organic and conventional (i.e. Kiwigreen) orchards throughout the Bay of Plenty in NZ, to compare the responses of those fruit to typical postharvest handling and storage regimes and their compositional attributes. Generally, fruit from conventional orchards were harvested more mature, as indicated by soluble solids concentrations (SSC), although the average firmness of fruit from the two systems did not differ significantly. The average concentrations of N, K, magnesium (Mg) and phosphorous (P) in fruit did not differ significantly with production system. However, organic fruit often contained

more Ca with the average difference being on the borderline of significance. Despite differences in maturity, whole fruit softening did not differ significantly with production system. On the other hand, fruit from organic orchards nearly always developed less soft patches than fruit from conventional orchards with the average difference being significant. This difference may have been partly due to the difference in the Ca concentration of fruit. Typical postharvest handling practices, compared to harvesting directly into trays, did not significantly affect whole fruit softening but did significantly decrease the incidence of soft patches, for reasons that are not clear. Across all the grower lines, the incidence of soft patches was significantly and negatively associated with the average concentrations of Ca in fruit. Combinations of other fruit attributes (i.e. SSC, initial firmness and the concentrations of N and Mg) with Ca concentration, produced indicators that were very strongly associated with the incidence of soft patches. These attributes would appear to be important in the development of soft patches. If these relationships are subsequently shown to be consistent, then they could form the basis for a predictive tool that would allow at-harvest segregation of fruit lines with different storage potentials.

In all of the current work, fruit that developed soft patches consistently contained less Ca than healthy fruit. It therefore seems that enhancing the Ca content of fruit could be beneficial to fruit storage life. However, it appears that under some conditions at least, the uptake of minerals, particularly Ca, may be constrained at the root level and so manipulating the soil environment may not always guarantee an improvement in the storage potential of kiwifruit.

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## Chapter 2 Literature Review



## Chapter 3 Soil Amendments and the Storage Potential of Kiwifruit

# List of Symbols and Abbreviations

| | | |
|---|---|---|
| - SP | = | without soft patches |
| µL | = | microlitre |
| [Ca] | = | calcium concentration ($mmol.kg^{-1}$) |
| [K] | = | potassium concentration ($mmol.kg^{-1}$) |
| [Mg] | = | magnesium concentration ($mmol.kg^{-1}$) |
| [N] | = | nitrogen concentration ($mmol.kg^{-1}$) |
| [P] | = | phosphorous concentration ($mmol.kg^{-1}$) |
| + SP | = | with soft patches |
| ANOVA | = | analysis of variance |
| B | = | boron |
| $C_2H_4$ | = | ethylene |
| Ca | = | calcium |
| CA | = | controlled atmosphere storage |
| $CaCl_2$ | = | calcium chloride |
| $CaNO_3$ | = | calcium nitrate |
| cm | = | centimetre |
| CMM | = | Complementary Michaelis-Menten |
| $CO_2$ | = | carbon dioxide |
| $COO^-$ | = | carboxyl group |
| CPPU | = | N-(2-chloro-4-pyridyl)-N'-phenylurea |
| CPRR | = | Centre for Postharvest and Refrigeration Research |
| Cu | = | copper |
| cvs. | = | cultivars |
| DF | = | degrees of freedom |
| dwt | = | dry weight (kg) |
| *f* | = | firmness (N or kgf) |
| F.O.B. | = | free on board |
| FCU | = | Fruit Crops Unit |

| | | |
|---|---|---|
| fwt | = | fresh weight (kg) |
| g | = | gram |
| galA | = | galacturonic acid |
| GLM | = | general linear model |
| $H_2SO_4$ | = | sulphuric acid |
| ha | = | hectare |
| HCl | = | hydrochloric acid |
| HR | = | HortResearch |
| HRGP | = | hydroxyproline-rich glycoprotein |
| K | = | potassium |
| KCl | = | potasssium chloride |
| kg | = | kilogram |
| kgf | = | kilograms force |
| L | = | litre |
| LSD | = | least significant difference |
| m | = | metre |
| M | = | molar |
| Mg | = | magnesium |
| mL | = | millilitre |
| mm | = | millimetre |
| mmol | = | millimole |
| mol | = | mole |
| mPa | = | millipascal |
| MSE | = | mean square error |
| N | = | Newtons |
| N | = | nitrogen |
| *n* | = | number |
| $N_2$ | = | nitrogen gas |
| Na | = | sodium |
| ND | = | non-destructive |

| | | |
|---|---|---|
| $NH_4^+$ | = | ammonium |
| NLIN | = | non-linear |
| $NO_3^-$ | = | nitrate |
| NZ | = | New Zealand |
| NZKMB | = | New Zealand Kiwifruit Marketing Board |
| $O_2$ | = | oxygen |
| °Brix | = | degrees Brix |
| °C | = | degrees Celsius |
| P | = | phosphorous |
| *P* | = | probability |
| PG | = | polygalacturonase |
| PGRS | = | plant growth regulator sprays |
| PME | = | pectinmethylesterase |
| RH | = | relative humidity (%) |
| RLD | = | root length density ($m.L^{-1}$) |
| rpm | = | revolutions per minute |
| SE | = | standard error |
| SP | = | soft patch |
| Sr | = | strontium |
| SS | = | soluble solids |
| SSC | = | soluble solids concentration (°Brix) |
| *t* | = | time (days) |
| T | = | temperature (°C) |
| w / w | = | weight per weight |
| XET | = | xyloglucan endotrans-glycosylase |
| Zn | = | zinc |