*Himachal Journal of Agricultural Research 34 (1):43-48, 2008*

# Standardization of leaf tissue for foliar sampling in kiwifruit (*Actinidia deliciosa* Liang and Ferguson)

**N.C. Sharma and J.S.Chandel**
Department of Pomology, College of Horticulture
Dr. Y.S. Parmar University of Horticulture and Forestry, Solan-173 230, India.

**Abstract**

**In order to standardize the leaf sampling techniques for nutrient diagnostic, chemical analysis of four leaf tissues (leaf blade, petiole, leaf blade + petiole and ½ leaf blade +petiole) was carried out in samples collected at monthly interval from June to September. The result revealed that N, Fe and Mn were significantly higher in leaf blade, whereas, P, K, Ca, Mg, Cu and Zn contents in petiole than other leaf tissues sampled. However, leaf blade + petiole exhibited the intermediate concentration of all the estimated nutrient elements with lowest co-efficient of variation for N, P, K, Ca, Mg and Zn. Leaf N, K, Cu and Zn contents decreased with the advancement of season from June to September in leaf blade, leaf blade + petiole and ½ leaf blade + petiole but did not show any consistent trend in petiole except for Zn, which increased throughout the season. P decreased throughout the sampling period in leaf blade and leaf blade + petiole, whereas, in petiole and ½ leaf blade + petiole no consistent seasonal pattern was observed. Mg and Mn were increased throughout the sampling period in leaf blade + petiole and ½ leaf blade + petiole, however, failed to show any consistent pattern in leaf blade and petiole. Similarly, Fe did not show any definite seasonal trend in all the sampled leaf tissues. On the basis of medium nutrient contents and least co-efficient of variation values, leaf blade + petiole was found to be most suitable tissue for nutrient diagnostic purpose in kiwifruit.**

Key words: Kiwifruit, *Actinidia deliciosa*, leaf tissue, nutrient contents, seasonal variation.

## Introduction

The kiwifruit (*Actinidia deliciosa* Liang and Ferguson) is a deciduous fruiting vine native to China. It is the most recently introduced fruit crop in our country, which has gained commercial importance in mid hills because of high economic returns. Although area under this fruit crop in Himachal Pradesh has undergone rapid increase in the last two decades, yet the nutritional requirements for its optimal fruit production has not been determined. In kiwifruit, nutrition plays an important role in production of quality fruits as fruit quality is directly related to nutritional status of the vine. Leaf analysis has been recommended as an index of nutritional status of fruit trees (Leece, 1968) irrespective of the available nutrient supply in the soil. Presently leaf analysis is widely accepted as a valuable diagnostic technique for assessing the nutritional status of the plants. Since the leaf nutrient contents are reported to vary with the sampling tissue, therefore the present studies were undertaken to standardize the most suitable leaf tissue for nutrient diagnostic purpose.

## Material and Methods

A field experiment was conducted on 14-years-old bearing kiwifruit vines of cv. Allison, planted at 4m x 6m distance and trained on T-bar system at Experimental orchard of the Department of Pomology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan. Samples of four leaf tissues (leaf blade, petiole, leaf blade + petiole and ½ leaf blade +petiole) were collected from middle part of current season's fruiting growth at monthly interval from 1st of June to 1st of September. The experiment was laid in a split plot design in which sampling times were taken as main plot and leaf tissues as sub-plots. Each treatment was replicated four times. Leaf samples collected in perforated polyethylene bags were brought to the laboratory in ice box and thoroughly washed, dried at 65±5° C for 48 hours, crushed to fine powder and stored in butter paper bags for chemical analysis (Chapman, 1964). Chemical analysis for N was accomplished by Micro-Kjeldahl method (AOAC, 1980), P by Vanado-molybdate phosphoric acid yellow colour

method (Jackson, 1973) and K, Ca, Mg, Cu, Zn, Fe and Mn by Atomic Absorption Spectrophotometer. Two years data were pooled and then subjected to statistical analysis.

## Results and Discussion

***Effect of leaf tissue on nutrient status*:** The data presented in Table 1 revealed that macro nutrient contents varied significantly with leaf tissues. Leaf blade contained significantly higher N content (2.43%) as compared to other leaf tissues sampled. Leaf blade + petiole, however, had significantly lower N content (2.26%) than leaf blade, but showed the least co-efficient of variation (5.43). Leaf P (0.37%), K (2.32%), Ca (3.67%) and Mg (1.01%) contents were found to be significantly higher in petiole than other leaf tissues sampled but least co-efficient of variation values of 9.38, 6.90, 5.22 and 10.90, respectively were observed in leaf blade + petiole.

It is evident from the data (Table 2) that among the micro nutrients, Cu (31.91ppm) and Zn (53.09 ppm) contents were found to be significantly higher in petiole than other leaf tissues sampled. However, least co-efficient of variation for Cu (10.39) was observed in petiole and for Zn (10.47) was recorded in leaf blade + petiole. Fe (234.80 ppm) and Mn (86.04 ppm) contents were recorded maximum in leaf blade, which were significantly higher than other leaf tissues sampled. Half leaf blade + petiole exhibited the lowest co-efficient of variation (2.43) for Fe and petiole (10.12) for Mn contents. The results of present studies are in agreement with the findings of (Cummings, 1977), who observed higher concentration of N, Fe and Mn in leaf blade and P, K, Ca, Mg, Cu and Zn contents in petiole of grape leaves. Higher accumulation of N, Fe and Mn in leaf blade is quite conceivable since leaf lamina is rich in chlorophyll content and nitrogen is a constituent of chlorophyll content. Fe plays a role in porphyrin structure of chlorophyll (Mengel and Kirkby, 1996) and Mn is involved in chlorophyll synthesis or breakdown as it is involved in chloroplast formation (Nason and McElroy, 1963). Petiole on the other hand acts as a bridge between leaf blade and rest of the tree for transport of the metabolites.

***Effect of sampling time on leaf nutrient status*:** Data with respect to macro nutrient contents of the leaves (Table1 and Fig.1) revealed that N and K contents in leaf blade, leaf blade + petiole and ½ leaf blade + petiole were found to be maximum during first sampling in June and decreased with the advancement of the season. However, in petiole, N content increased initially from 1.70 per cent in June to 2.16 per cent in August and decreased thereafter to 1.61 per cent in September. K content in petiole also increased initially from 2.37 per cent in June to 2.67 per cent in July but decreased thereafter to 2.04 per cent in September. P content decreased throughout the sampling period from June to September in leaf blade and leaf blade + petiole. However, in ½ leaf blade + petiole and petiole, P content decreased from June to August but increased thereafter in the month of September. Ca content increased with the advancement of the season from June to September in all the leaf tissues sampled. Although, Mg content in leaf blade + petiole and ½ leaf blade + petiole increased throughout the sampling period from June to September but in leaf blade and petiole it did not show any consistent pattern where it decreased initially from 0.89 percent in June to 0.63 per cent in July and increased thereafter to 0.92 per cent during September in leaf blade and increased initially from 0.88 per cent in June to 1.21 per cent in July and decreased thereafter to 0.93 per cent during September in petiole.

Data pertaining to variation in micro nutrients in various leaf tissues analysed (Table 2 and Fig.2), revealed that Cu and Zn contents in leaf blade, leaf blade + petiole and ½ leaf blade + petiole were found to be maximum during first sampling in June and decreased with the advancement of the season. Cu content decreased from 35.50 ppm in June to 27.38 ppm in July and increased thereafter to 34.75 ppm in September, whereas, Zn content increased throughout the sampling period from 40.00 ppm in June to 66.13 ppm in September in the petiole. Mn contents in leaf blade + petiole and ½ leaf blade + petiole increased with the advancement of the season throughout the sampling period, however, its content in leaf blade increased initially from 74.88 ppm in June to 97.13 ppm in August and decreased thereafter to 87.63 ppm in September, whereas, in petiole, it failed to show any consistent seasonal pattern. Similarly, Fe content did not show any definite seasonal trend in all the sampled leaf tissues.

The higher concentration of N, P and K early in the season might be due to the fact that

**Table 1. Effect of leaf tissues and sampling time on leaf macro nutrient status of kiwifruit**

| Sampling time/ Leaf tissues | June | July | August | September | Mean | Coefficient of variation |
|---|---|---|---|---|---|---|
| | **Nitrogen (%)** | | | | | |
| Leaf blade only | 2.72 | 2.49 | 2.33 | 2.18 | 2.43 | 8.23 |
| Petiole only | 1.70 | 1.93 | 2.16 | 1.61 | 1.85 | 11.55 |
| Leaf blade +petiole | 2.44 | 2.28 | 2.20 | 2.10 | 2.26 | 5.43 |
| ½ Leaf blade + petiole | 2.19 | 2.01 | 1.92 | 1.82 | 1.99 | 6.85 |
| Mean | 2.27 | 2.18 | 2.15 | 1.93 | | |
| CD (P=0.05) | Leaf Tissue | | | 0.07 | | |
| | Sampling time | | | 0.09 | | |
| | Sampling time at a given leaf tissue | | | 0.21 | | |
| | **Phosphorus (%)** | | | | | |
| | June | July | August | September | Mean | Coefficient of variation |
| Leaf blade only | 0.33 | 0.27 | 0.24 | 0.23 | 0.27 | 11.94 |
| Petiole only | 0.43 | 0.41 | 0.30 | 0.35 | 0.37 | 14.86 |
| Leaf blade +petiole | 0.36 | 0.32 | 0.30 | 0.29 | 0.32 | 9.38 |
| ½ Leaf blade + petiole | 0.39 | 0.37 | 0.29 | 0.31 | 0.34 | 9.41 |
| Mean | 0.38 | 0.34 | 0.28 | 0.30 | | |
| CD (P=0.05) | Leaf Tissue | | | 0.02 | | |
| | Sampling time | | | 0.03 | | |
| | Sampling time at a given leaf tissue | | | 0.06 | | |
| | **Potassium (%)** | | | | | |
| | June | July | August | September | Mean | Coefficient of variation |
| Leaf blade only | 2.48 | 2.24 | 2.12 | 1.87 | 2.18 | 10.09 |
| Petiole only | 2.37 | 2.67 | 2.21 | 2.04 | 2.32 | 9.99 |
| Leaf blade +petiole | 2.44 | 2.22 | 2.15 | 2.02 | 2.21 | 6.90 |
| ½ Leaf blade + petiole | 2.56 | 2.29 | 2.16 | 1.95 | 2.24 | 9.87 |
| Mean | 2.46 | 2.35 | 2.16 | 1.97 | | |
| CD (P=0.05) | Leaf Tissue | | | 0.03 | | |
| | Sampling time | | | 0.04 | | |
| | Sampling time at a given leaf tissue | | | 0.09 | | |
| | **Calcium (%)** | | | | | |
| | June | July | August | September | Mean | Coefficient of variation |
| Leaf blade only | 2.47 | 2.92 | 3.21 | 3.36 | 2.99 | 11.35 |
| Petiole only | 3.11 | 3.58 | 3.89 | 4.10 | 3.67 | 10.15 |
| Leaf blade +petiole | 2.78 | 3.04 | 3.21 | 3.32 | 3.09 | 5.22 |
| ½ Leaf blade + petiole | 2.88 | 3.16 | 3.33 | 3.41 | 3.20 | 6.35 |
| Mean | 2.82 | 3.18 | 3.42 | 3.55 | | |
| CD (P=0.05) | Leaf Tissue | | | 0.09 | | |
| | Sampling time | | | 0.12 | | |
| | Sampling time at a given leaf tissue | | | 0.28 | | |
| | **Magnesium (%)** | | | | | |
| | June | July | August | September | Mean | Coefficient of variation |
| Leaf blade only | 0.89 | 0.63 | 0.87 | 0.92 | 0.83 | 13.92 |
| Petiole only | 0.88 | 1.21 | 1.01 | 0.93 | 1.01 | 12.06 |
| Leaf blade +petiole | 0.77 | 0.95 | 1.01 | 1.03 | 0.94 | 10.90 |
| ½ Leaf blade + petiole | 0.76 | 0.97 | 1.07 | 1.11 | 0.98 | 13.86 |
| Mean | 0.83 | 0.94 | 0.99 | 1.00 | | |
| CD (P=0.05) | Leaf Tissue | | | 0.03 | | |
| | Sampling time | | | 0.03 | | |
| | Sampling time at a given leaf tissue | | | 0.08 | | |

**Table 2. Effect of leaf tissues and sampling time on leaf macro nutrient status of kiwifruit**

| Sampling time/ Leaf tissues | June | July | August | September | Mean | Coefficient of variation |
|---|---|---|---|---|---|---|
| | | | **Copper (ppm)** | | | |
| Leaf blade only | 30.12 | 23.75 | 23.25 | 19.87 | 24.25 | 15.21 |
| Petiole only | 35.50 | 27.38 | 30.00 | 34.75 | 31.91 | 10.39 |
| Leaf blade + petiole | 29.62 | 25.00 | 23.25 | 21.25 | 24.78 | 12.48 |
| ½ Leaf blade + petiole | 32.62 | 28.00 | 25.75 | 23.50 | 27.47 | 12.28 |
| Mean | 31.97 | 26.03 | 25.57 | 24.85 | | |
| CD (P=0.05) | Leaf Tissue | | | 2.35 | | |
| | Sampling time | | | 2.93 | | |
| | Sampling time at a given leaf tissue | | | 7.08 | | |
| | | | **Zinc (ppm)** | | | |
| | June | July | August | September | Mean | Coefficient of variation |
| Leaf blade only | 42.63 | 33.13 | 27.50 | 21.88 | 31.28 | 24.48 |
| Petiole only | 40.00 | 49.88 | 56.38 | 66.13 | 53.09 | 17.93 |
| Leaf blade + petiole | 43.38 | 39.50 | 35.50 | 33.00 | 37.84 | 10.47 |
| ½ Leaf blade + petiole | 49.13 | 44.13 | 37.50 | 34.00 | 41.19 | 14.28 |
| Mean | 43.79 | 41.66 | 39.22 | 38.75 | | |
| CD (P=0.05) | Leaf Tissue | | | 4.11 | | |
| | Sampling time | | | 2.97 | | |
| | Sampling time at a given leaf tissue | | | 10.90 | | |
| | | | **Iron (ppm)** | | | |
| | June | July | August | September | Mean | Coefficient of variation |
| Leaf blade only | 248.70 | 223.10 | 240.60 | 226.90 | 234.80 | 4.35 |
| Petiole only | 243.10 | 203.70 | 228.70 | 213.70 | 222.30 | 6.72 |
| Leaf blade + petiole | 225.00 | 246.90 | 230.60 | 223.10 | 231.40 | 4.05 |
| ½ Leaf blade + petiole | 222.50 | 236.90 | 227.50 | 224.40 | 227.80 | 2.43 |
| Mean | 234.90 | 227.60 | 231.90 | 222.00 | | |
| CD (P=0.05) | Leaf Tissue | | | 7.88 | | |
| | Sampling time | | | 7.30 | | |
| | Sampling time at a given leaf tissue | | | 21.86 | | |
| | | | **Manganese (ppm)** | | | |
| | June | July | August | September | Mean | Coefficient of variation |
| Leaf blade only | 74.88 | 84.50 | 97.13 | 87.63 | 86.04 | 10.12 |
| Petiole only | 62.38 | 52.00 | 72.75 | 66.25 | 63.35 | 11.88 |
| Leaf blade + petiole | 61.00 | 74.63 | 82.75 | 86.63 | 76.25 | 12.84 |
| ½ Leaf blade + petiole | 59.13 | 77.00 | 87.38 | 95.37 | 79.72 | 16.97 |
| Mean | 64.35 | 72.04 | 85.00 | 83.97 | | |
| CD (P=0.05) | Leaf Tissue | | | 3.33 | | |
| | Sampling time | | | 3.67 | | |
| | Sampling time at a given leaf tissue | | | 9.66 | | |

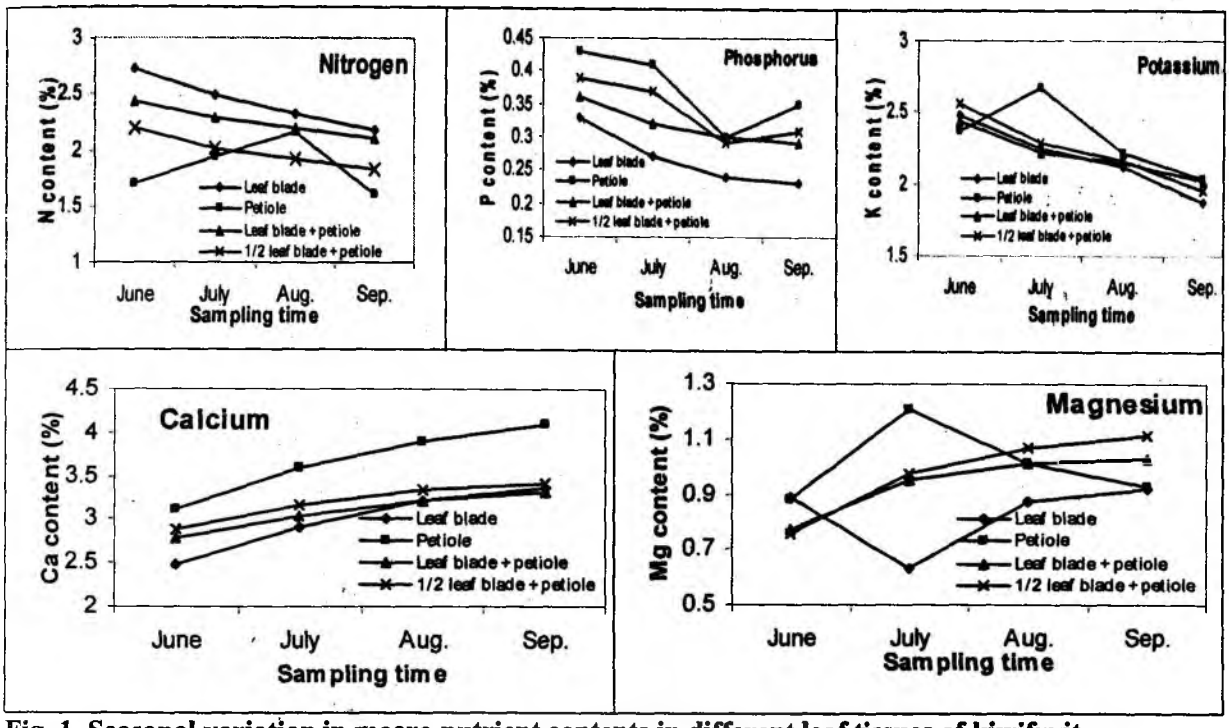



**Fig. 1. Seasonal variation in macro nutrient contents in different leaf tissues of kiwifruit**

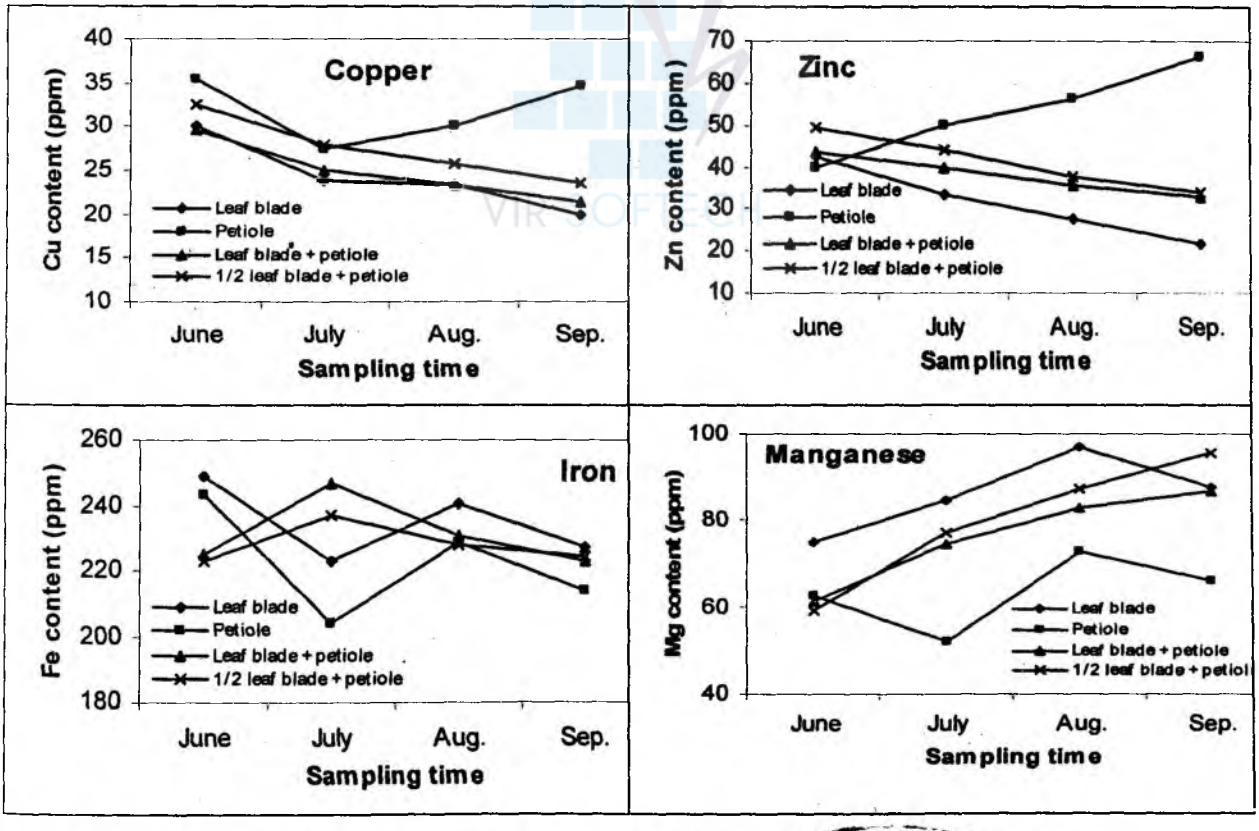



**Fig.2.Seasonal variation in micro nutrient contents in different leaf tissues of kiwifruit**

96222

these nutrient elements originates from reserve sources of the plant from previous year and mobilized early in the spring (Ferguson and Tumer, 1981). Decrease in nutrients with the advancement of season might be associated with the competition of new developing sinks (either vegetative or reproductive and translocation of nutrients to the other organs (Loupassaki *et al.*, 1997). A steady increase in leaf Ca, Mg and Mn with advancement of season might be due to the continuous accumulation of these nutrients through transpiration stream. The results of present studies are in line with those of Battelli and Renzi (1990) and Therios *et al.* (1997) who also observed decrease in N, P, K, Cu and Zn and increase in Ca, Mg and Mn contents throughout the season in the leaves of kiwifruit.

**References**


AOAC 1980. *Official Methods of Analysis*. Association of Official Analytical Chemists, Washington, DC, USA.

Battelli, G and Renzi, G 1990. A nutritional survey of kiwi orchards in Northern Italy. Acta Hortic. **282**: 173-85.

Chapman, HD 1964. Suggested foliar sampling and handling techniques for determining the nutrient status of some field, horticultural and plantation crops. Indian J. Hort. **21 (2)**: 97-119.

Cummings, GA 1977. Variation in the concentration of certain elements in Muscadine grape leaves related to season, leaf portion and age. J. Amer. Soc. Hort. Sci. **102 (3)**: 339-42.

Ferguson, IB and Turner, NA 1981. Mobilization of macronutrients in cuttings of kiwifruits (*Actinidia chinensis* Planch). Ann. Bot. **47**: 229-37.

Jackson, ML 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Leece, DR 1968. The concept of leaf analysis for fruit trees. J. Aust. Inst. Agri. Sci. **34**: 146-53.

Loupassaki, MH, Androulakis, II and Lionakis, SM 1997. Effect of P and K fertilizer and of the date of sampling on the concentration of macro- and micro-elements in the leaves of four kiwi cultivars. Acta Hortic.**444**: 249-54.

Mengel, K and Kirkby, EA 1996. *Principles of Plant Nutrition*. Panima Publishing Co. Daryaganj, New Delhi.

Nason, A and McElroy, WD 1963. Modes of action of the essential elements. In: *Plant Physiology- A Treatise*. Vol. III, ed Stewart FC, Academic Press, New York.

Therios, I, Taraksi, C, Christaki, S, Dimassi, TK, Sfakiotakis, E and Porlingis, J 1997. Seasonal variation of mineral composition of kiwifruit (*Actinidia deliciosa*) in northern Greece. Acta Hortic. **444**: 261-65.


VIR SOFTECH