

## The Effect of Terbacil on Chlorophyll Content of Strawberry (*Fragaria × ananassa* cv. ‘Honeoye’) Leaves<sup>1</sup>

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In this research terbacil was used as a tool to study chlorophyll regeneration in strawberry (*Fragaria × ananassa* cv. ‘Honeoye’) leaves. Strawberry plants which are in two different growth stages (During fruit set and after harvest) were applied with 50, 100 and 200 ppm terbacil. Chlorophyll a, chlorophyll b, proto-chlorophyll and total chlorophyll contents were measured with 4 days of intervals up to 16 days. Chlorophyll a and total chlorophyll content decreased within 4 days of terbacil application. However, recovery was observed after 4 days. Stage of the development did not affect this recovery process.

**Keywords:** Terbacil, strawberry, chlorophyll, *Fragaria ananassa*

### Terbacil Uygulamasının Çilek (*Fragaria × ananassa* cv. ‘Honeoye’) Yapraklarındaki Klorofil Miktarına Etkisi

Bu araştırmada, terbacil çilek (*Fragaria × ananassa* cv. ‘Honeoye’) yapraklarındaki klorofil rejenerasyonu çalışmaları için bir araç olarak kullanılmıştır. İki farklı gelişme evresindeki (Meyve tutumu evresi ve derim sonrası evresi) çilek bitkisi yapraklarına 50, 100 ve 200 ppm terbacil uygulanmıştır. Klorofil a, klorofil b, proto-klorofil ve toplam klorofil miktarları 4 gün ara ile 16. güne kadar ölçülmüştür. Klorofil a ve toplam klorofil miktarları terbacil uygulamasından 4 gün sonra azalmış. Ancak 4. günden sonra klorofil miktarlarında yeniden bir artış gözlenmiştir. Gelişme devresinin yeniden artış işlevi üzerine bir etkisi olmamıştır.

**Anahtar Kelimeler:** Terbacil, çilek, klorofil, *Fragaria ananassa*

### Introduction

Terbacil is a uracil type herbicide that blocks both the Hill reaction and photosystem II in the photosynthetic pathway (Ashton,1977). Terbacil was used on fruit trees as a method to limit photosynthesis can cause thinning (DelValle, 1985). Others have used terbacil as a tool to investigate the damage thresholds (Byers, 1990; Disegna, 1994). In this research, the effect of terbacil on chlorophyll content of strawberry leaves was investigated. Since, chlorophyll content may be an indicator of the photosynthetic efficiency. Recovery of chlorophyll formation was investigated after such damage occurred. In this research, terbacil was used to simulate damage to the photosynthetic process and whether it can be used to study for recovery process of the plants

such chlorophyll regeneration and recovery of photosynthesis.

The tolerance of strawberry to terbacil has been shown to be at least partially attributable to restricted translocation of root-absorbed herbicide to the site action in mesophyll chloroplasts. Uptake by the root did not appear to be a factor in tolerance to terbacil (Genez, 1983).

Honeoye, Guardian and Darrow strawberry cultivars are reported to susceptible to terbacil. Recommended rate is 138-419 g/ha. 559 g/ha are found to be toxic to the strawberry. Rate should be chosen depending on the soil type. Lower rate suggested on coarse type soils (Mahret.al., 2002).

<sup>1</sup>This paper consists of a part of the Ph.D. thesis

Toxic effects of 400 ppm of terbacil was observed in Honeoye strawberry cultivar (Makaracı, 2003).

'Chambly' strawberry a hybrid of Sparkle X Honeoye, is reported to be tolerant to terbacil (Khanizadeh, 1990).

## Materials and Methods

Terbacil applications were performed at two different stages of plant development: "during fruit set" and "after harvest stage". Applications were sprayed to different set of plants.

Strawberry plants (*Fragaria ananassa* cv. Honeoye) were planted in three raised beds (20 cm height, 50 cm width) at Michigan State University Horticulture Teaching and Research Center (HRTC), East Lansing, MI, USA. Each bed had two rows of plants, 20 cm apart, and the distance between the plants within a row was 30 cm. The treatments consisted of a single application of terbacil at concentrations of 50 ppm, 100 ppm and 200 ppm. X-77 (90%) surfactant (Alkylaryl polyoxyethylene, Alkyl polyoxyethylene, Fatty acids, Glycols and Dimethyl poly siloxane) was added to the herbicide at a concentration of 1.25 ml/L. Control plants were sprayed with water plus surfactant at 1.25 ml/L. Leaves were sprayed to the dip point. Border plants were used to separate treatment plots. Plants were drip irrigated as follows: One drip line placed per hill. Capacity of dripper was 4 L/h. Irrigation applied for 40 minutes at 7:30 am every day by a Torro irrigation timer (Model 53331, Bloomington, MN). A 20-20-20 (N,P,K)

## Results and Discussion

Terbacil reduced chl a and total chlorophyll content of the strawberry leaves in both growing stages (Figure 1 and Figure 2). This reduction was observed 4 days after terbacil application. The same pattern was also observed in total chl content. Reduction in chl b content was only significant in "after harvest stage" 4 days after terbacil application in 200 ppm treatment. However, total chl and chl a content recovered 4 days after application and there was no significant difference after 12 days. Terbacil did not affect chl b and P chl content (Figure 1 and figure 2). This was consisted with results of Izawa (1965) and Disegna (1994). An increase in chl a followed

This research was conducted based upon the hypothesis that certain terbacil levels can be used to study the chlorophyll regeneration. It is also considered that stage of development may also affect chlorophyll regeneration. Thus, plant growth stage was also considered.

fertilizer was applied three times during the growing season at a rate of 5 grams per plant. Straw mulch was used as the mulching material. Manual weeding was performed as necessary. No pesticides were applied to the strawberry plants during the experiment and no significant insect or disease damage was observed during the experiment.

Four plants were selected for each treatment plot which has three replicates. Three leaf discs (0.33 cm<sup>2</sup>) were removed from three different leaves on each plant using a paper punch hole. Chlorophyll was extracted by placing the leaf discs in 7 ml N,N-dimethylformamide for 36 hours in the dark at a temperature of 5°C. Absorbance of the extracts at wavelength of 664, 647 and 625 nm was measured using a Hitachi U-3110 spectrophotometer (Hitachi Ltd, Tokyo, Japan). The concentration of chlorophyll a (chl a), chlorophyll b (chl b) and protochlorophyll (P chl) was calculated according to the methods proposed by Moran (1982).

Chlorophyll content was determined one day before the treatments and 4, 8, 12, 16 days after the terbacil treatments.

Data was analyzed by standard deviation.

the reduction of chl a and total chl indicating that chl a generated in recovery process after 6 days.

P chl content did not fluctuated until the 12<sup>th</sup> day of terbacil application. This may explain that the recovery of the chl a content in both growing stages. The decrease in P chl content at the 16<sup>th</sup> day of terbacil application may be explained due to the aging effect of the leaves. The aging effect can also be observed at the 16<sup>th</sup> day of the terbacil as decrease in total chl content. There was no apparent effect of plant growth stage except a small decrease in chl b content at 200 ppm level ant at the 4<sup>th</sup> day of application in "after harvest stage".

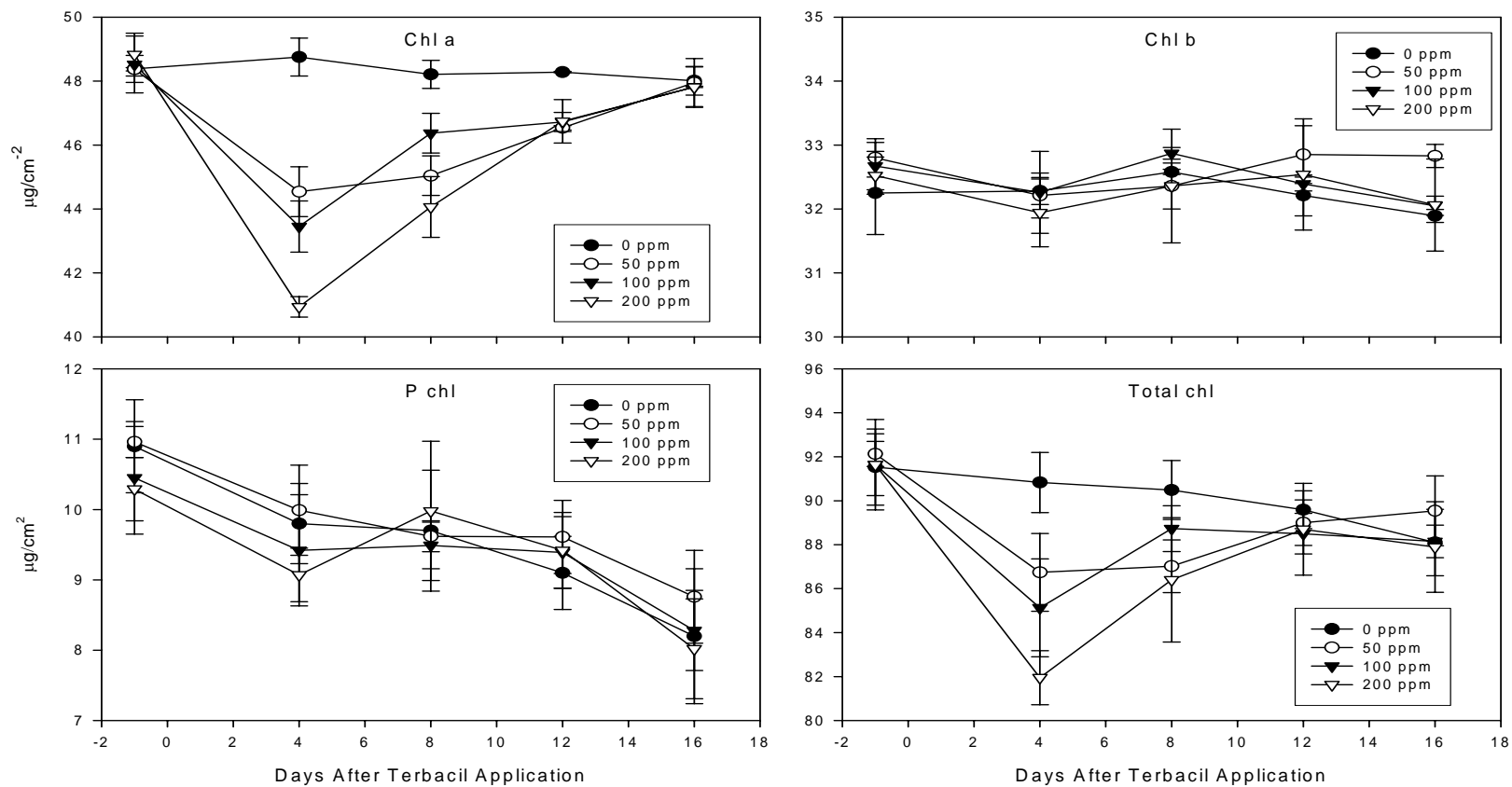


Figure 1. Effect of terbacil on total chl, chl a, chl b and P chl (During Fruit Set Stage)

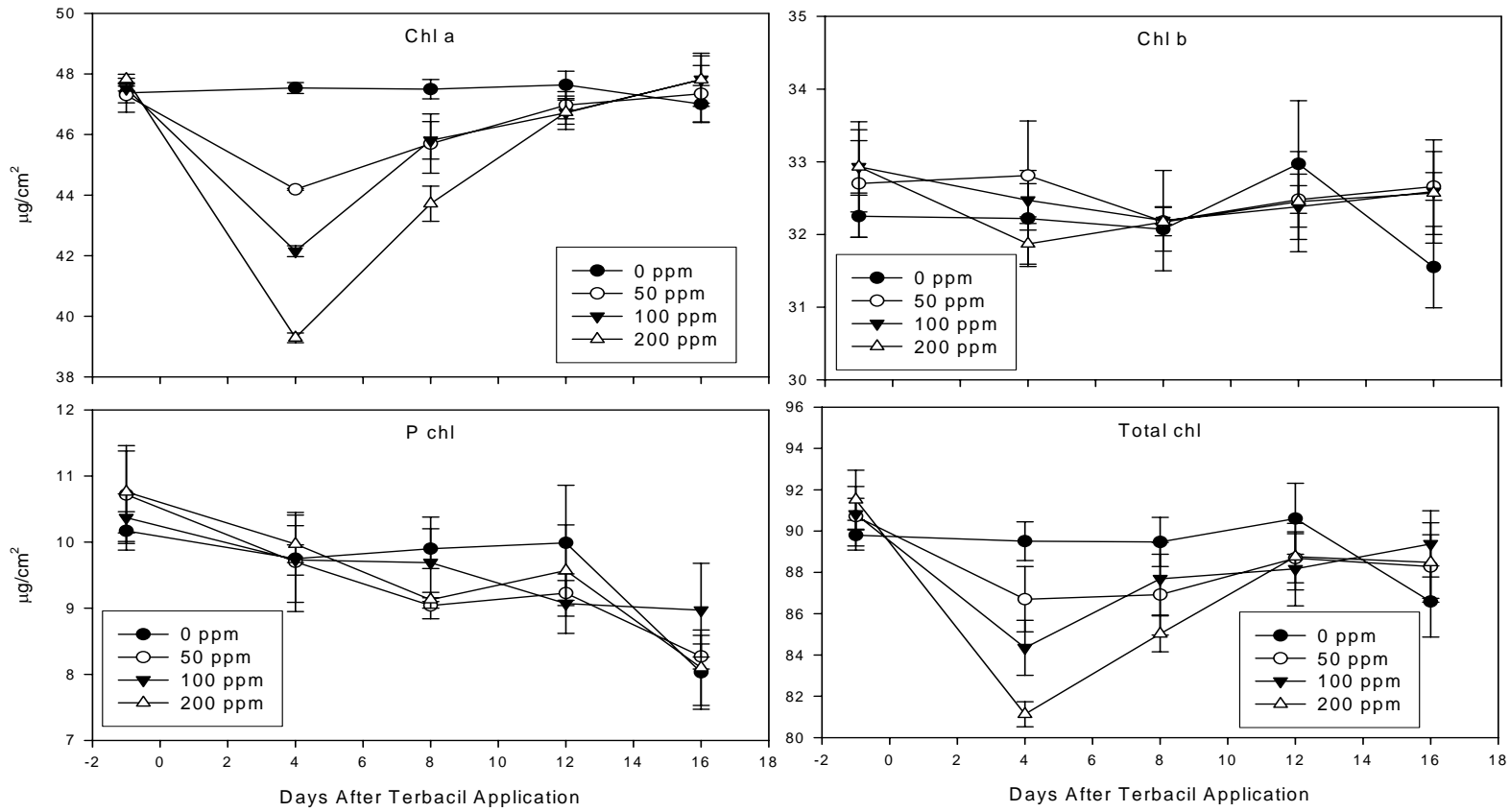


Figure 2. Effect of terbacil on total chl, chl a, chl b and P chl (After Harvest Stage)

## Conclusions

Terbacil was useful to investigate the chlorophyll regeneration of the strawberry leaves. Total chlorophyll and chl content was affected from terbacil treatments and temporary chl a reduction occurred. However, results indicated recovery processes exists in strawberry leaves to regenerate chlorophyll. Non-fluctuated P chl content may be an indicator of the regeneration process. Aging of

the leaves may be a limiting factor in this recovery. It should be considered that in this research only full expanded leaves were used when terbacil applied. It can be expected that different ages of the leaves may react differently.

This research concluded that terbacil can be used to study damage thresholds and chlorophyll regeneration studies in strawberries.

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