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Changes in Ethylene and Total Nonstructural Carbohydrates Content in Stem Apex Prior to Leaf Flushing of Marian Plum (*Bouea burmanica* Griff.) cv. Toon Klaow

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ABSTRACT

Changes in ethylene and total nonstructural carbohydrate (TNC) content in stem apex prior to leaf flushing of marian plum (*Bouea burmanica* Griff.) cv. Toon Klaow were studied. It was found that ethylene concentration in the intercellular space was low and remained constant between the 4th to the 1st week prior to leaf flushing but the level increased to the maximum at leaf flush. Whereas, the TNC content reached the maximum level at the 4th week before leaf flushing, then decreased linearly to the minimal level at the week of leaf flushing.

Key words: ethylene concentration, TNC level, intercellular space

INTRODUCTION

Marian plum (*Bouea burmanica* Griff.) is a tropical fruit originated in Southeast Asia (Poolperm, 1993) and belong to the family Anacardiaceae. In Thailand, marian plum is gaining popularity among local consumers in recent year and the Thai Government is trying to help in exporting this fruit as some Thai companies have started to advertise marian plum fruit for export (Subhadrabandhu, 2001). At present, some selected cultivars have been known and planting area of these cultivars are increasing (Muchacheep, 1998). Furthermore, marian plum in Thailand flowers in November – December and fruits from April – May (Subhadrabandhu, 2001), thus harvesting season of marian plum does not coincide with other fruits and it has a good market in the country and being considered as another kind of fruits with bright future (Chairuangyod, 1996). However, marian plum is an irregular flowering and has low production in some years, this may be due to the flowering behavior which required a short period of cool dry weather for flowering (Chairuangyod, 1996). Temperature has been reported to be a major factor influencing flowering (Poolperm, 1996).

The mechanism of flowering can be explained in two ways. One, native flowering hormones are synthesized up to required level. The other, is the control of balance between natural hormones. However, at present there is no evident to support these hypotheses (Tongumpai, 1994). Although, the nutrition in plant may play a role to promote flowering but it may not be a factor in control of flowering (Bernier *et al*., 1985)

Moreover, leaf flushing was one of the factors that counteract flowering process (Menzel and Simpson, 1992). In generally, most perennial fruit trees do not flower when they are in vegetative growth (Tongumpai, 1994).

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There are many speculations that plant hormones may involve in flowering of several fruit trees, reports on the study of hormone balance, such as gibberellin, cytokinin and ethylene were know in many fruit trees e.g. lychee (*Litchi chinensis* Sonn.) and mango (*Mangifera indica* L.) (Chen, 1990 ; Tongumpai *et al.*, 1997) but non was done in marian plum. However, methods in producing off – season marian plum had been attempted. Chairuangyod (1996) used paclobutrazol at the rate 10 g (ai) / meter of branch diameter and found that after applying as soil drench for 2 – 3 months, the marian plum did not flower and the percent of flowering in season crop is not different from that of the control. In 1993, Chairuangyod sprayed the marian plum trees with macronutrient, micronutrient and seaweed extract at the rates 50 ml/ 20 liter and found that the treated trees flowered in early September whereas the control trees did not flower. However, knowledge of plant hormones in marian plum in correlation with the hormonal balance and flowering has not been studied. In this experiment the changes of ethylene in stem apex as an information to study the hormone balance prior to leaf flushing in marian plum was investigated.

Stephenson and Cull (1986) reported that flowering may be resulted from the effect of nutrition in plant. Thus the study on the nutrient status in trees and plant hormone at leaf flushing may be useful in explaining the relations between vegetative and reproductive growth. The research reported in this paper was undertaken to study on changes in ethylene and total nonstructural carbohydrate content during leaf flushing of marian plum cv. Toon Klaow that may be the basic information for future research on hormone balance during flowering and control of suitable level of ethylene content and the nutrient status in stem apex of marian plum.

MATERIALS AND METHODS

Five years old marian plum trees from Wang Nam Kang orchard, Mae Wang district, Chiang Mai, were used in this study. Stem apices were collected at 0, 1, 2, 3 and 4 weeks prior to leaf flushing (July 19 to August 16, 1997). Each stem apex was cut in 10 cm long with the leaves detached, and brought to the Laboratory of Horticulture Department, Faculty of Agriculture, Chiang Mai University. The stem apices were divided into 2 groups having 10 stem apexes per group. The first group was taken for extracting gas from the intercellular space and the ethylene concentration was analyzed by gas chromatography. The second was taken for analyzing TNC content.

Ethylene content analysis

Gas extraction method was modified from Saltveit (1982) (Figure 1). The vacuum at pressure 600 mmHg for 2 minutes was applied and a sample of gas extract was taken by 1 ml syringe. The ethylene content of gas sample was chromatographically measured. Ethylene was measured with a hydrogen flame ionization detector (FID). One – milliliter gas samples were injected with a gas sampling valve at 90°C on a stainless steel column that packed the PorapakN 80 – 100 inside, with helium at 75 ml/min as the carrier gas.

TNC content analysis

The stem apices were washed with distilled water and dried at 60°C for 72 hr, they were ground

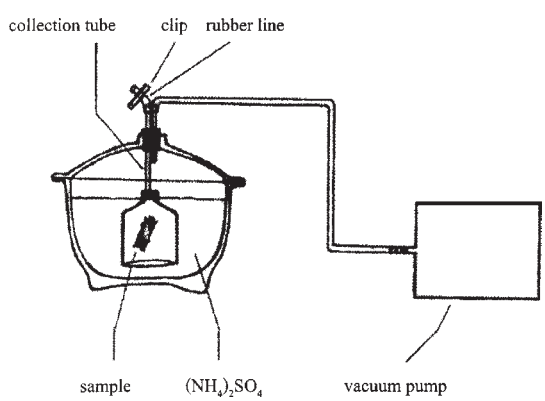

Figure 1 An apparatus for extracting the intercellular gases from stem apex.

with a Willey intermediate mill that threw pass a 40 mesh sieve . The ground sample was kept in paper closed bag in the dessicator. Before extraction, the humidity of sample was measured by AOAC method (1984). The method of sample extraction was followed by Chaitrakulsub (1983) and carbohydrate content was measured by Shaffer-Somogyi Copper Iodometric Titration method (AOAC, 1984).

RESULTS

It was found that the level of ethylene concentration in the intercellular space was constantly low during the week 4th to 1st prior to leaf flushing, and then the level increased at the week of leaf flushing.(0.7579, 0.6971, 0.7443, 0.7309 and 0.8829 ppm, respectively)(Figure 2)

Total nonstructural carbohydrate (TNC) content in marian plum stem apex decreased linearly. The value was a maximum at the 4th week and then decreased to a minimum value at leaf flushing (75.68, 96.86, 59.50 and 81.70 mg glucose equivalent/gram dry weight, respectively) (Figure 3)

DISCUSSION

Ethylene concentration in the intercellular space of marian plum stem apex cv. Toon Klaow increased at the week of leaf flushing. Whereas in lychee (*Litchi chinensis* Sonn.) cv Hong Huay, the pattern of ethylene was different. Ethylene concentration in stem apex of lychee increased at the 3rd week before leaf flushing and remain constant till leaf flushing time (Lerslerwong, 2001). Moreover, the amount of ethylene concentration in stem apex of marian plum was less than that in lychee. Davenport and Nunez-Elisea (1991) studied ethylene content of mango (*Mangifera indica* L.) cv. Tommy Atkins in shoot leaf , stem and inflorescence prior to flowering and found that when flower bud was not induced, ethylene content at the dormant stage was not different from that at the flowering stage. Because ethylene can induce flowering in pineapple (Zeiger, 1998), thus most researchers are interested in using exogenous ethylene for flower induction and some inhibitor to reduce leaf flushing in some fruit trees such as lychee. For example Chaitrakulsub *et al.* (1992) found that the chemical treatments, ethephon and

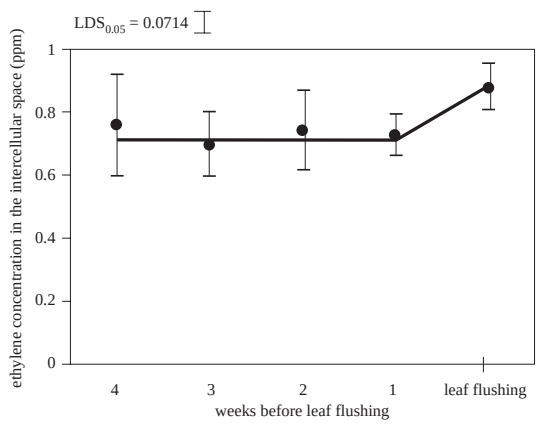

Figure 2 Variation in ethylene content in stem apexes of marian plum cv. Toon Klaow prior leaf flushing.
CV. = 10.39% (untransform), 10 replications

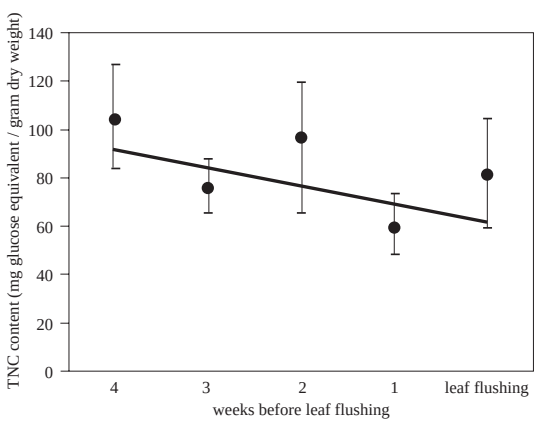

Figure 3 Variation in TNC content in stem apexes of marian plum cv. Toon Klaow prior leaf flushing.
CV. = 18.77% (untransform), 8 replications

paclobutrazol, promoted flowering about three times more than control tree and controlled trees flushed leaf much more than untreated tree, while leaf flushing on the treated trees had very few flushes. Thus ethylene may be related to induce flowering and vegetative flushes in marian plum as shown in Figure 2.

Moreover, the endogenous hormones such as cytokinin, abscissic acid, gibberellin and auxin, in other fruit trees were studied (Chen, 1999). Chen(1999) reported that the level of cytokinin and abscissic acid in shoot tip of lychee cv. Heh Yeh at the period of leaf flushing was lower than that at flowering. Whereas, gibberellin content was high at the period of leaf flushing and then the level decreased when the flower bud was formed, however, the indole acetic acid (IAA) content was nearly the same level in both stages of leaf flushing and flowering.

The effect of plant growth regulator on the level of endogenous hormone was studied. Tongumpai *et al.* (1997) studied an effect of applied paclobutrazol as soil drench to mango cv. Khiew Sawoey prior to flowering. They found that the paclobutrazol treated mango flower and at that time the level of gibberellin was low and non detectable. It is believed that in many perennial tree, flowering occurred when the level of gibberellin was low (Tongumpai, 1994). Thus applying some growth retardants may be one mean of decreasing gibberellin level for inductive flowering.

Total nonstructural carbohydrate of marian plum cv. Toon Klaow was linearly decreased at the 4th week prior to leaf flushing and continued to decrease until leaf flushing. Where as in lychee cv. Hong Huay, TNC content was high at 1 month before the time of leaf flushing and decreased at the 3rd week and not changed till leaf flushing(Lerslerwong, 2001) . It was interpreted that the accumulation of TNC content occurred before the week of leaf flushing and decreased at leaf flushing.

Furthermore, the nutrient level in the other fruit trees was studied (Scholefield *et al*., 1984; Mataa and Tominaga, 1998). The carbohydrate level of avocado cv. Fuerte was low after the leaf flushing was occurred (Scholefield *et al*., 1984). It was probably true that low carbohydrate level has resulted in vegetative growth limitation and thus promoting flower. Whereas, Mataa and Tominaga (1998) reported that in *Citrus reticulata* which had less vegetative growth, the TNC content in leaf will increase and lead to flowering.

Although, little is known about plant hormone balance, that is responsible in control flowering, and we need a lot of experiments to clarify, however the result reported here will be a basic information of plant hormone balance and the way of using growth regulator that effect on biochemical process in plant for control of suitable levels of ethylene and carbohydrate levels in stem apex of marian plum for regular flowering.

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