Chapter 1

Introduction

Lychee or litchi *(Litchi chinensis* Sonn.) is the most popular member of the Sapindaceae family that includes the related longan and rambutan. Lychee originated in the area near southern China and northern Vietnam, but now spreads to many countries. The largest producers are in South-East Asia (China, Vietnam and Thailand). There are at least 100 varieties, but cultivation is generally limited to fewer than ten cultivars in most production areas (Menzel, 2001). Lychee is mainly grown in the northern part of Thailand, where the climate is classified as sub-tropical, it is known to be less adaptable than other crops (Subhadrabandhu and Yapwattanaphun, 2001).

One of the major problems of lychee growers in Thailand is the irregularity of the yield. The main reason of low and irregular cropping is the poor flowering behavior in some year. Menzel and Simpson (1990) also reported the same problem for lychee growing in subtropical areas of Australia. This problem may be solved by genetic improvement and invention of some cultural practices, such as, cincturing, irrigation control, fertilizer application and application of plant growth regulators. However, Subhadrabandhu (1990) reported that lychees respond quickly to changes in the environment and cultivars are not readily adaptable to a wide range of localities. Most of the cultivars grown in the northern part of Thailand need the minimum temperature of about 10^0-15^0C and rainfall less than 60-80 mm. in cold season for flower initiation. Menzel and Simpson (1987) also agreed that lychee was inherently one of the most unpredictable performer of the fruit crops. Small changes of environment make huge differences to performance of many cultivars. Cincturing or girdling had been shown to reduce vegetative flushing and increase flowering of some lychee cultivars, but the results had not always been consistent. Cincturing increased flowering by 40-80% in the trees which flowered poorly in spring (<70%) but cincturing did not significantly affect (P>0.05) flowering in the trees which flowered profusely (70-100%). Cincturing can reduce or delay flowering if nutrition is not maintained (Menzel and Simpson, 1987). Sometimes, cincturing reduced flowering in the trees which would have flowered profusely. This occurred when the cincture recovered prematurely to allow vegetative flushing in winter. These results suggested that some loss of yield may occur (Menzel and Paxton, 1986). Hong Huay, the major cultivar grown in northern Thailand, has been forced to flower by cincturing for many years but the results suggested that Hong Huay did not response to cincturing as good as Chakrapad and Kwang Jow.

Irrigation control, withholding of water one or two months before flowering is a common practice in Thai lychee orchards, but irregular flowering is still the problem. Menzel (1983) concluded that there was often a strong correlation between floral initiation and water stress in lychee, but a direct relationship had not been established. Some year later, Menzel *et al*. (1989) studied the effect of leaf water stress and reported that flushing was completely prevented when plants were held at a severe constant leaf water stress (-2.0 MPa). They concluded that water stress appeared to act by synchronizing vegetative dormancy before exposure to low temperatures.

Improvement of genetic, new technique of cultural practices and application of plant growth regulators for controlling flowering of lychee are investigated by many researchers but the results are variable. Menzel and Simpson (1990) concluded that the main reason of low and irregular cropping was excessive vegetative growth in the 1-2 months before panicle formation and, subsequently poor flowering in spring. They tried to control excessive vegetative growth by the application of paclobutrazol as foliar spray at the concentrations of 1,000 - 4,000 ppm and soil drench at 0.25 - 1.00 gm.ai/m^2 tree ground cover. They found that lychee trees increased in flowering with paclobutrazol only when the growth retardant inhibited vegetative growth for 1-2 months before panicle emergence. There was no improvement in flowering when paclobutrazol merely delayed the development of vegetative flush. Ethephon was also reported to increase lychee flowering in Thailand (Subhadrabandhu, 1986) and China (Huang and Weng, 1978).

Lychee and longan are the two most popular members of the Sapindaceae. They have similar botany and share common characteristics such as three different flower types and have arillate fruit. However, they differ in fruit morphology, environmental adaptation, fertility, fruit size, colour and flavour. Longan usually grows in the north of Thailand because it needs low temperature around 10-20^{0}C for flower induction (Thanyapa, 1995). It is known that environmental stresses, e.g. low temperature, day length, humidity, nutrients, soil structure and water content affect biochemical processes in cells and cell division and in consequence affect bud development particularly morphogenesis of leaf or floral buds. In addition, all these factors influence carbohydrate and nitrogen contents and hormone balance of the trees, resulting in alternation of growth stages i.e. vegetative or reproductive (Subhadrabandhu, 1990).

Flower induction by chlorate was accidentally discovered. The chemical in the form of potassium chlorate ($KClO_3$) has been applied to longan, especially for off-season fruit production. At present, the off-season production is popular among the longan growers because they received higher price than in the normal season. Normally, the growers applied $KClO_3$ by soil drench (Manochai, 2000).

Manochai *et al.* (1999) reported that potassium chlorate application at 8 $g.m^{-2}$ as soil drench could induce 100% off-season flowering in longan cv. Daw. The reduction of $KClO_3$ application from 8 to 4 $g.m^{-2}$ reduced the flowering percentage of the tree to 86 %. However, $KClO_3$ at the concentrations of 1-4 $g.m^{-2}$ could induce a 100% flowering in longan cv. See Chompoo.

Flowering can be induced with $KClO_3$ sprays at the concentration of 1 $g.L^{-1}$. Less chemical is used and there is lower residuals in the soil compared with drenching. $KClO_3$ 1 $g.L^{-1}$ could induce up to 97 % flowering, with some leaf shed. More leaf shed was found at high concentration and high temperature condition (Sritontip *et al.*, 1999).

$KClO_3$ as soil drench is the most effective treatment to induce flowering in longan (Manochai *et al.*, 1999). Although it is known that $KClO_3$ can induce flowering in longan, but its mechanism for flower induction is still unclear (Pankasemsuk, 1999).

$KClO_3$ application in longan is known that it can induce flowering in longan all year round and sometimes it also increase flowering percentage. Lychee and longan are classified as plants in class genus. So, $KClO_3$ at the same or almost the same quantity as using in longan was applied to use with lychee for solving alternate bearing and induce off-season flowering. It was found that $KClO_3$ could not induce flowering in lychee. In additional, $KClO_3$ was toxic to lychee. After lychee was treated with $KClO_3$, the lychee trees developed leaf burn, defoliation and chlorosis symptoms and some trees died. There were some reports that paclobutrazol could increase flowering percentage in lychee. However, paclobutrazol could not induce flowering in lychee. In these studies, $KClO_3$ with paclobutrazol were applied to lychee for induce flowering. The concentration of $KClO_3$ treatments were reduced to avoid toxicity and paclobutrazol was used to reduce the internal gibberllin content. Some physiological change after treating with $KClO_3$ and paclobutrazol were also studied.

Objectives of this study

To study the effects of potassium chlorate with paclobutrazol on flowering, vegetative flushing and some physiological changes in lychee cv. Kom, Chakrapad and Hong Huay.