# Chapter 2

# Survey of gall midge infestation in farmer's rice field

## 2.1 Introduction

Rice gall midge is an important insect of rice that is widely distributed in Thailand (Tayathum *et al*., 2004). Damages by the gall midge are dependent on rice variety and environmental condition (Sardesai *et al.,* 2001). The insect attacks the rice crop from seedling to heading stages in the wet season and live in other host plants in the dry season, ready to infest rice again in the next wet season (Hidaka *et al*., 1974). The rice gall midge larva causes deformation of the growing point of the rice plant, turning the tiller into a tube-like gall, called 'silver shoot or onion leaf' which no longer has the capacity to develop into a panicle or grain, so there is a loss in grain yield. It has been reported that infestation levels caused by the rice gall midge vary among different areas where air temperature, rain fall and humidity differ. In addition, the rice gall midge from different areas can be of different biotypes. The gall midge from different areas in Thailand have been reported to vary in their virulence on different rice varieties (Tayathum *et al*., 1995)

Mae Moot village, Mae Win sub district, Mae Wang district, Chiang Mai province is one location identified with gall midge problem. Farmers in the village grow many local rice varieties such as Muey Nawng, Nahng Gao, Kulab Dang, Lueng Mae Jam, Kao Jao Khao, Bue Chor Mee and Leb Nahng as well as improved varieties

such as KDML105, RD6, and San-pah-tawng 1. Interviews with farmers found that Muey Nawng is generally recognized as resistant to gall midge, while the other varieties are infestation by gall midge to varying degrees in different seasons. This chapter investigates on how the rice gall midge infestation of farmer's rice varies over time during the growing season and rice varieties. The presence and abundance of known gall midge host plants during the off-season was also investigated.

## 2.2 Material and Methods

Two experiments were conducted form June 2003 to December 2004 at Mae Moot village, Mae Win sub district, Mae Wang district, Chiang Mai province, Thailand (Figure 2.1 and 2.2).

### 2.2.1 A survey of the host plants in farmer's rice field in the dry season

This experiment examined five alternative host plants of the rice gall midge: *Leersia hexandra* Sw. (swampy rice grass), *Echinochloa colona* (L.) Link (jungle rice), *Paspalum scrobiculatum* Linn. (rice grass paspalum) , *Ischaemum rugosum* salisb. (wrinkle duck-beak) and *Oryza rufipogon* Griff. (common wild rice) that have so far been recognized in Thailand (Hidaka *et al*., 1974) (Figure 2.3). The survey was conducted at Mae Moot village after rice harvesting in four types of habitat that included irrigation ditch, wet land, bunds in rice field and paddy field in six general areas of the village's rice field. Density of the alternative host plants of the rice gall midge was determined by visual observation in December to January, about one month following the rice harvest.

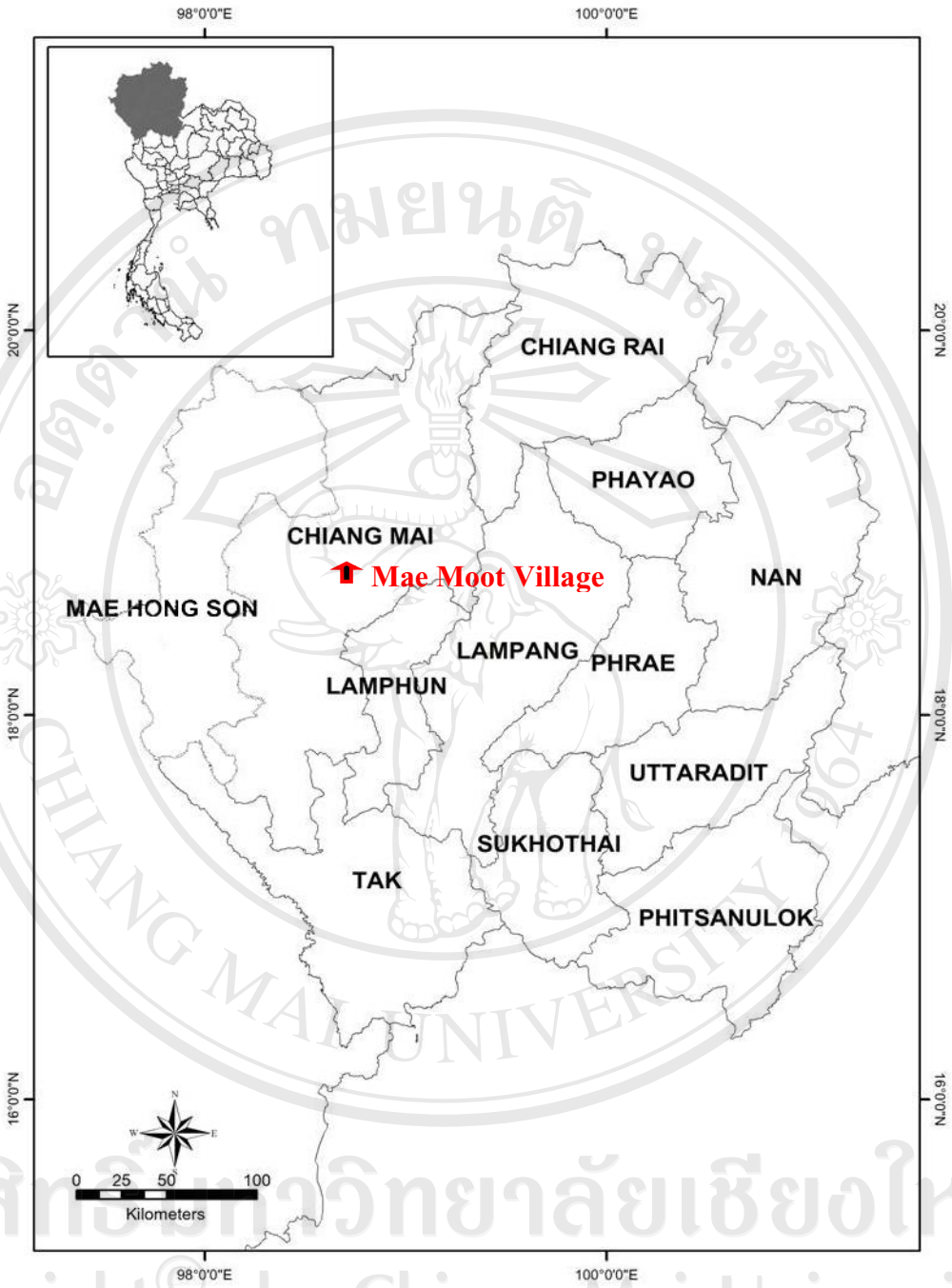


**Figure 2.1** Study site in Mae Moot village, Mae Win sub district, Mae Wang district, Chiang Mai province.

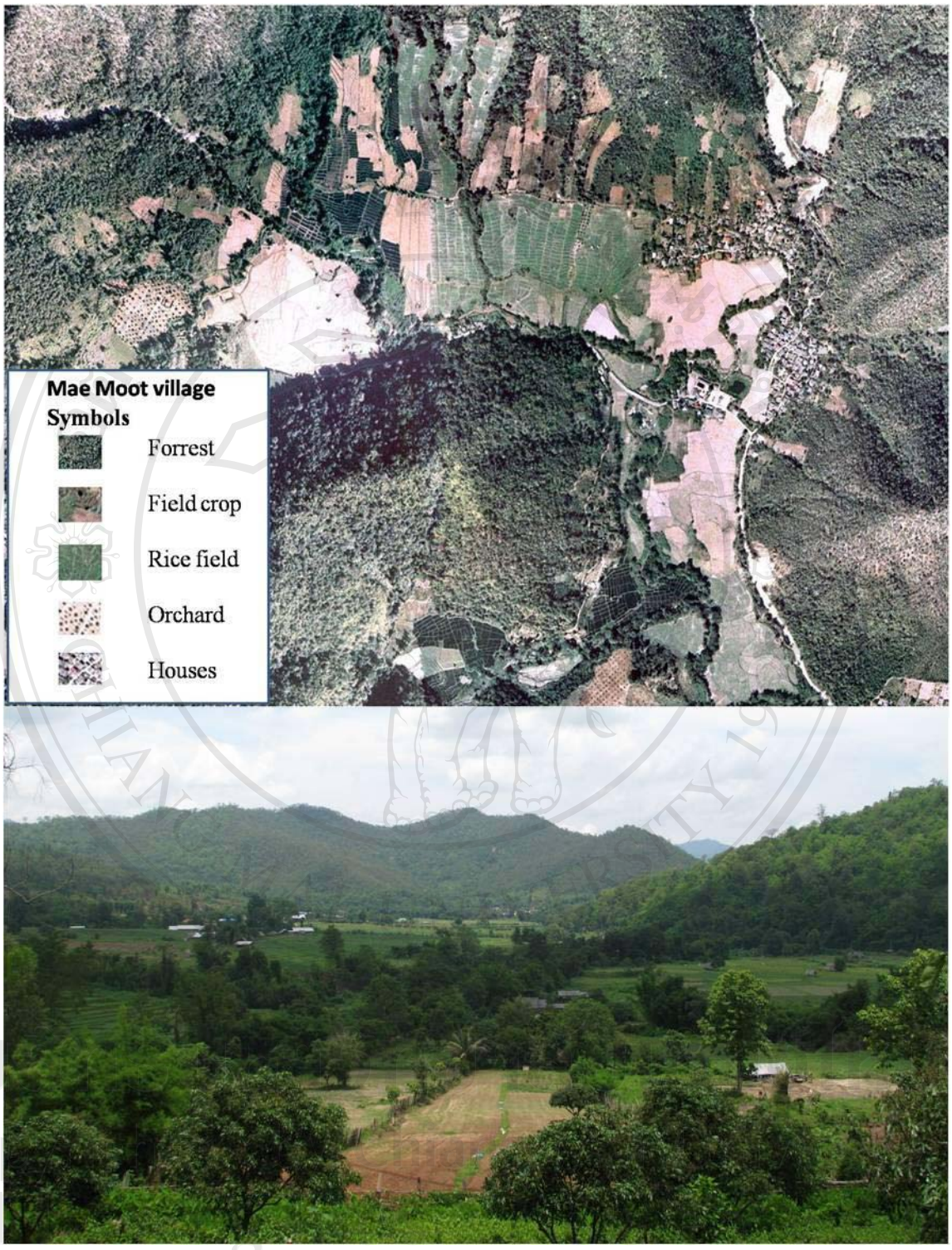


**Figure 2.2** Farmers' paddy field' in Mae Moot village, Mae Win sub district, Mae Wang district, Chiang Mai province.


**Figure 2.3** The five host plants: *Leersia hexandra* Sw. (swampy rice grass) (A), *Echinochloa colona* (L.) Link (jungle rice) (B), *Paspalum scrobiculatum* Linn. (rice grass paspalum) (C), *Ischaemum rugosum* salisb. (wrinkle duck-beak) (D) and *Oryza rufipogon* Griff. (common wild rice) (E).

**2.2.2 Variation in the number of gall midges over the rice growing season and variation in gall midge infestation in farmer's rice varieties**

Determination of the fluctuations in the gall midge population was done with light traps to catch adult gall midges. A light trap was located at the centre of each field growing four of farmer's rice varieties, starting from 4 weeks after rice transplanting. The rice varieties were those commonly grown in the village. They were farmer's own version of Muey Nawng, Nahng Gao (a local Karen variety), Phrae 1 (a modern varieties and sensitive to photoperiod) and RD6 (an aromatic, popular variety with tall plant type and sensitive to photoperiod). The light trap were composed of a two purple light bulbs (4 watts and 220 volts) suspended at 1.5 m from the ground above a bottle containing cyanide in the bottom for killing the insect, with plastic roofing to keep out the rain (Figure 2.4). The bottles were changed weekly and number of gall midge recorded form tillering to last heading stages for each rice variety. The number of silver shoots and productive tillers hill$^{-1}$ were counted every week on randomly selected 20 hills in four replications, from tillering to heading stage. The percentage of gall midge infestation is computed as follows:

Gall midge infestation (%) = (Ts / Tt ) × ( Hs / Ht ) × 100

Ts = Number of silver shoots per hill

Tt = Total number of tillers per hill (number of silver shoots per hill plus number of normal tillers per hill)

Hs = Number of hills with one or more silver shoots

Ht = Total number of total hills counted (in this case 20)


**Figure 2.4** Light trap (A) and cyanide bottle (B) for catch the adult rice gall midges on farmer rice field.

## 2.3 Results

### 2.3.1 Environment and climate at Mae Moot village

Mae Moot village is a typical upland village occupying a small foothill valley (Figure 2.2). The flat land on the valley floor has been developed into paddy fields. Village houses are clustered together on the eastern rim of the valley. A small stream called Mae Tian cuts through the middle of the village. Water for irrigation is provided by a small dam further up. The rice growing season is from June to November. Rice is sown in early June and transplanted one month later and harvested by mid November. After rice harvesting, the farmers grew second crop such as soybean, maize and vegetables. Generally, farmers plant glutinous or sticky rice types for household's consumption and non-glutinous rice for the market. In 2003, there were four main rice varieties with glutinous grain type. These included Muey Nawng, Nahng Gao, Phrae1 and RD6. The local rice variety, Muey Nawng is popular in this area and recognized for its resistance to the insect pest gall midge. Good quality seed of Muey Nawng is maintained by farmers who are skilled in seed selection. Usually, each farmer may grow one or more varieties each year, depending on his/her specific circumstance and needs. For example, those with a lot of paddy land may grow enough glutinous rice for the family's need, plus some high quality non-glutinous variety for the market. Those with fields in low lying areas that drain later may grow late maturing varieties. The growing of different varieties with different maturing time helps to stagger labor requirement.

The climate at Mae Moot village (in 2005 to 2006) is described by monthly mean temperature between in 23 to 28 $^{0}$C at May to November (wet season) and

between in 20 to 29 $^{0}$C at December to April (dry season). The rainy season starts in May and ends in October (Table 2.1).

**Table 2.1** Monthly mean temperature (ºC) and rainfall total (mm) measure in the period 2005 to 2006 at Mae Sapok Royal Project Development Center, about in two km from Mae Moot village, Mae Win Sub District, Mae Wang District, Chiang Mai Province.

| | Mean Temperature (°C) | | Rainfall (mm) | |
|---|---|---|---|---|
| Month | 2005 | 2006 | 2005 | 2006 |
| January | 21.3 | 21.1 | 0 | 0 |
| February | 24.5 | 23.7 | 0 | 5.9 |
| March | 26.1 | 27.4 | 14.9 | 12.0 |
| April | 28.7 | 27.3 | 105.8 | 32.9 |
| May | 27.8 | 25.9 | 175.1 | 405.6 |
| June | 26.7 | 27.7 | 206.8 | 182.3 |
| July | 26.4 | 26.9 | 199.7 | 287.9 |
| August | 25.8 | 26.7 | 142.5 | 342.6 |
| September | 25.8 | 26.7 | 382.0 | 655.3 |
| October | 25.5 | 26.3 | 119.4 | - |
| November | 23.5 | - | 36.5 | - |
| December | 20.5 | - | 15.3 | - |

**Note:** - No data. Mae Sapok Royal project Development Center is located at Mae Sapok village, Mae Win sub district, Mae Wang district, Chiang Mai province.

**2.3.2 Survey of host plants of the gall midge after farmer's rice field after rice harvested**

The different host plants of the rice gall midge were found distributed in different types of habitat, but with varying abundance (Table 2.2). *Leersia hexandra* Sw. was most abundant in the wet land, where it occupied four fifths and more of land area of the habitat. This aquatic species was also found in the irrigation ditch, but not on the bunds between rice fields or inside the paddy field. *Echinochloa colona* (L.) Link, which a common weed of the rice field was found occupying one fifth or less of land area within the paddy field and on the bunds, but not in irrigation ditch or wet land. *Paspalum scrobiculatum* Linn. and *Ischaemum rugosum* salisb. were only found occupying one fifth or less of land area of the bunds in rice field, but not in the other types of habitats. *Oryza rufipogon* Griff. was not found in this village.

**Table 2.2** Density of five alternative host plants of the rice gall midge in four types of habitats: irrigation ditch, wet land, bunds in rice field and paddy field at Mae Moot village, Mae Win Sub district, Mae Wang district, Chiang Mai province.

| Host plants | Irrigation ditch | Wet land | Bunds in rice field | Paddy field |
|---|---|---|---|---|
| *Leersia hexandra* Sw. (swamp rice grass, หญ้าไทร) | + | +++++ | - | - |
| *Echinochloa colona* (L.) Link (jungle rice, หญ้านกสีชมพู) | - | - | + | + |
| *Paspalum scrobiculatum* Linn. (rice grass paspalum, หญ้าปล้องหิน) | - | - | + | - |
| *Ischaemun rugosum* salisb. (wrinkle duck-beak, หญ้าแดง) | - | - | + | - |
| *Oryza rufipogon* Griff. (wild rice, ข้าวป่า) | - | - | - | - |

Note: - (not found), + (occupying one fifth or less of land area), ++ (occupying one to two fifths of land area), +++ (occupying two to three fifths of land area), ++++ (occupying three to four fifths of land area) and +++++ (occupying four fifths and more of land area).

### 2.3.3 Variation in the number of gall midges over the rice growing season and variation in gall midge infestation in farmer's rice varieties

**Number of rice gall midge**

The number of rice gall midges varied over the duration of collection and rice varieties (Figure 2.5). The number of rice gall midge in four rice varieties fluctuated in 2-3 cycles through the rice growing season. The first cycle was during 4 to 8 weeks after rice transplanting. By 5 weeks after transplanting there were very few gall midges in all rice varieties. Some differences in number of gall midges were observed among the varieties at 6 weeks after transplanting, when the number of insects collected was 40 over Phrae1, 20 over RD6, about 10 over Nahng Gao and nil over Muey Nawng. The first peak was reached in Muey Nawng, RD6 and Nahng Gao at 7 weeks with 50, 45 and 39 gall midges week$^{-1}$, respectively. The number of gall midges in Phrae 1, however, declined after the maximum at 6 weeks. The number of gall midges in all rice varieties declined to a minimum at 8 weeks. The second cycle was in 8 to 12 weeks after transplanting. After 8 weeks after transplanting, the number of gall midges was increased in all of varieties. The number of rice gall midges was the highest in 10 and 11 weeks after transplanting in Nahng Gao and Muey Nawng of 85 and 40 gall midges week$^{-1}$, respectively. The number of insects in Phare1 had two more peaks at 9 and 11 weeks after transplanting, with 32 and 41 gall midges week$^{-1}$, after which it decreased until the heading stage. RD6 had the highest the numbers rice gall midge at 10 weeks after rice transplanting and it decreased at 11 weeks after transplanting. However, the number rice gall midges increased in RD6 at week 12 but the other varieties declined.

**Normal tillers hill$^{-1}$**

Normal tillers are those with normal leaves. At 5 weeks after transplanting, the number of normal tillers hill$^{-1}$ did not differ among rice varieties, which was about 6 normal tillers hill$^{-1}$. Most varieties had the highest number of normal tillers hill$^{-1}$ during 6 to 8 weeks after transplanting. At 6 weeks after transplanting, Muey Nawng and RD6 had the highest number of normal tillers hill$^{-1}$ (23 normal tillers hill$^{-1}$). At 7 weeks after transplanting, Muey Nawng, Phrae1 and RD6 had higher number of normal tillers hill$^{-1}$ than Nahng Gao. However, the number of normal tillers hill$^{-1}$ was highest in Phrae1 of 28 normal tillers hill$^{-1}$ at 8 weeks after transplanting. After 8 weeks after transplanting, the number of normal tillers in most of the rice varieties were declining, except, RD6 which produced even more tillers at 13 weeks after transplanting. The heading stage was found in Phrae1 at week 10, Muey Nawng at week 12, RD6 and Nahng Gao at week 13. In heading stage, Phrae1 and RD6 had higher the number of normal tillers hill$^{-1}$ than Muey Nawng and Nahng Gao. In harvesting stage, the declination of normal tillers hill$^{-1}$ in all varieties was produced the number of productive tillers hill$^{-1}$ which can produce the panicles hill$^{-1}$. The productive tillers hill$^{-1}$ was declined in 14%, 20%, 33% and 33% of Muey Nawng, Phrae 1, RD6 and Nahng Gao, respectively (Figure 2.6).



**Percentage gall midge infestation**

Based on the percentage infestation by rice gall midge, the 4 rice varieties were separated into two groups: low and high percentage of infestation. The low percentage of infestation was found in Muey Nawng and Phrae1 about 0-3 and 0-2 % at 5 weeks after transplanting to heading stage. The high percentage of infestation

was found in Nahng Gao and RD6. These varieties had the increasing percentage of infestation by rice gall midge at 5 week after transplanting and the highest peaks percentage of infestation by rice gall midge was found about 45 % at 10 weeks after rice transplanting. At week 10 to heading stage, the infestation percentage of Nahng Gao was decreased but not in RD6 (Figure 2.7).

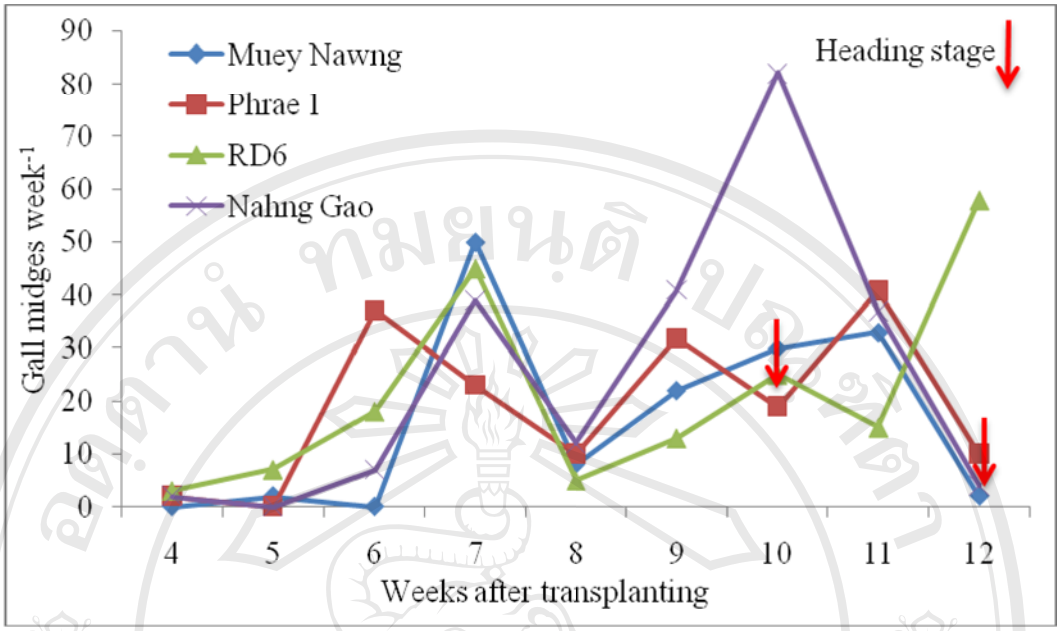


**Figure 2.5** Number of rice gall midge collected from light traps over four rice varieties: Muey Nawng, Phrae 1, RD6 and Nahng Gao, in farmer's field at Mae Moot village. *The heading stage of RD6 and Nahng Gao at 13 weeks after transplanting.

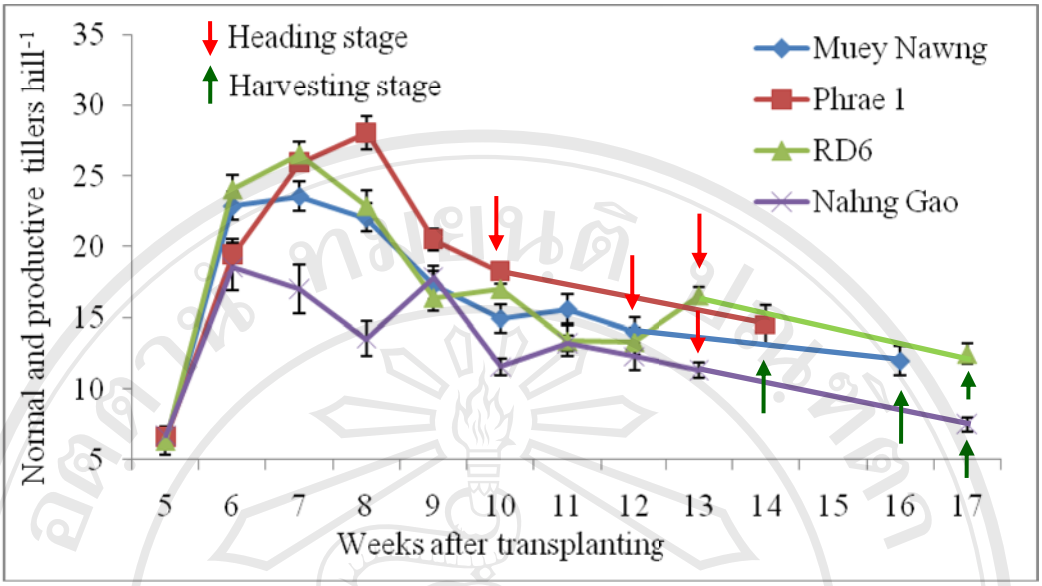


**Figure 2.6** Number of normal and productive tillers hill$^{-1}$ (with error bars, n=4) in four rice varieties: Muey Nawng, Phrae 1, RD6 and Nahng Gao, in farmer's field at Mae Moot village. Assessment was made during tillering to heading stage.

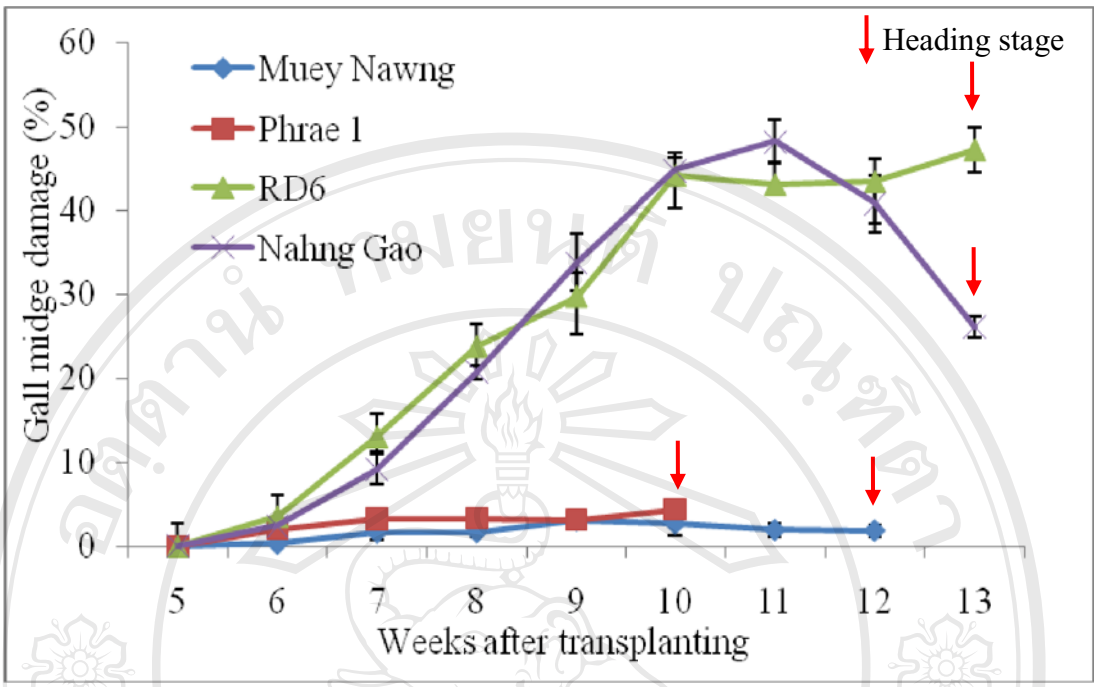


**Figure 2.7** Gall midge infestation (%) in four rice varieties: Muey Nawng, Phrae 1, RD6 and Nahng Gao, in farmer's field at Mae Moot. Assessment was made during tillering to heading stage. Error bars represent ± SE (n=4).

## 2.4 Discussion

The rice gall midge infestation of the rice crop varies with the ecological environment. Heavy infestations are found at average temperature between 23.4°C and 26.9°C, with high relative humidity of 85% to 95%, cloudy days with about 4 sunshine hours and at least 600 mm of rain during the growing season (Majumder *et al*., 2003). The monthly mean temperature of 26ºC at Mae Moot village during the growing season of rice falls within the range of temperature that favors the gall midge infestation. In addition, relative humidity rises to 80-90% during the months of heavy rains from June, which totaled more than 1000 mm in the growing season that lasted 5 months. The rain and high relative humidity is favorable for oviposition behavior of the female gall midge, hatching of the eggs, larval penetration into the growing point of the rice plant, and emergence of the full grown insects from the galls or silver shoots (Hidaka *et al*., 1974). The village's geography of in the foothills, with a small area of rice fields surrounded by forested mountains dense with vegetation, also agreed with Tayathum *et al*., (1995). They described paddy fields with gall midge problem as land in small valleys surrounded by large forested mountain areas dense with vegetation. Moreover, the finding of 4 out of 5 host plants of the gall midge is an indicator of the prevalence of the gall midge and the potential damage to the rice (Hidaka *et al*., 1974). The high abundance of swamp rice grass (*Leersia hexandra* Sw.) in the wetlands at Mae Moot village has a special implication for the rice gall midge problem and its control. In permanent wetland, the perennial swamp rice grass can live all year round, providing the habitat and food for the gall midge during the off-season for rice.

The number gall midge adults, normal tillers and percentage of infestation varied over time, with different patterns in different rice varieties. The number of gall midge adults increased and decreased in 2-3 cycles. This partly agrees with Hidaka *et al*., (1974) that the number of rice gall midge had increased after tillering stage and had two peaks between June to December in Northern Thailand. It is known that the life cycle of rice gall midge is 28 – 30 day under favorable condition. The two main peaks of the number gall midge adults appear to coincide with the time required between generations of the insect. Other fluctuations over shorter time that differ between the rice varieties, however, could suggest a variation in the preference for different rice varieties of the gall midge adults.

The rice variety Muey Nawng and Phrae1 had the lower percentage of infestation by rice gall midge than Nawng Gao and RD6. The results of Muey Nawng confirmed farmers' observation that the variety is resistant to the gall midge. Indeed, an accession farmer's seed of the local variety Muey Nawng from Chiang Mai was selected and pure lined and released as gall midge resistant Muey Nawng 62 M in 1972. While Phrae 1 contains the gall midge resistance gene from W1252 (a gall midge resistant line from India) and preferred by farmers for its earliness as well as resistance to the gall midge. Unfortunately, eating quality of the glutinous variety is not as good as RD6. However, RD6, which produces high quality glutinous rice, is highly susceptible to damage by the gall midge, and is usually used susceptible check in green house screening in Thailand's national rice breeding program. The response of susceptible varieties to gall midge infestation was showed the high the number of normal tillers in vegetative stage (Tayathum *et al*., 1995). The results confirmed the high number of normal tillers hill in susceptible of RD6 but susceptible of Nahng Gao

found the lowest number of normal tillers hill$^{-1}$. However, all of varieties of productive tillers hill$^{-1}$ were decreased until heading stage. During decreasing of productive tiller, it's were die of productive tillers or product silver shoots by rice gall midge infestation. At heading stage, most of rice varieties were not infestated by rice gall midge in field, it was lack of favorable habit and possibly of nutritional subsistence (Harris *et al*., 2003). This agree in this experiment found that the number of productive tiller was declined in all of varieties form heading to harvesting stage

In conclusion, the ecological and climate were opportunity survivals of rice gall midge at Mae Moot village. Thus, the high density of *Leersia hexandra* Sw. on wet land was main host plant of rice gall midge on dry season. The number of gall midges in rice fluctuated with time and rice varieties. Moreover, the rice varieties also had different markly resistant to infestation by rice gall midge. Therefore, the higher infestation by rice gall midge was found among 10-12 weeks after rice transplanting in susceptible varieties. So, the rice gall midge infestation in rice varieties at Mae Moot village was great field tests. Thus, the next chapter was investigated how the farmers popularize the local Muey Nawng varieties at this village and different accessions of local Muey Nawng in different villages were resist to rice gall midge infestation in field condition.