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SAFFLOWER INSECTS AND SURVEYING TECHNIQUES

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ABSTRACT : During the 1986 Safflower growing season, field studies were conducted at Mae Hia Research Station and Training Center, Chiang Mai, and Wieng Papao, Chiang Rai, to determine the species of safflower insects and their abundances, the safflower key pests and their economic thresholds, and the most effectiveness of surveying methods among direct observe method, sweep net catch, and D-Vac machine.

The total of 21 insect pest species, 6 beneficial insect species and various species of the predacious spiders were collected from both safflower experiment fields.

Among all sap sucking insects, the aphids (*Uroleucon* sp.) and the tobacco whiteflies *(Bemisia tabaci)* were the two predominant species collected at Chiang Mai experiment field, while the jassids (*Empoasca* sp.), the tobacco whiteflies *(Bemisia tabaci)*, and the white-backed planthoppers *(Sogatella furcifera)*, were the three predominant species occurred at Chiang Rai experiment field. Although their damage to the safflower vegetative parts were not reached the economic injury level. their ability in plant disease transmission needed to be further investigated. The leaf beetles, the grasshoppers, and the leaf-eating caterpillars caused little damage to the safflower vegetative parts. Nevertheless, the *Heliothis* caterpillars had ability to destroy the safflower heads and were determined to be the future key pests of safflower.

The D-Vac machine was significantly the most efficient method among the three sampling methods employed in collecting the small and active sucking insects, the leaf beetles, the braconids, and the spiders. The direct observe method could detect the whiteflies and the spiders, signicantly better than the sweep net catch. The D-Vac machine and the visual search, both were significantly better in detecting the grasshoppers than the sweep net catch. The direct observe method was the best method for detecting the populations of safflower caterpillars, the ladybird beetles, and the syrphid maggots.

INTRODUCTION

In northern Thailand, farmers usually grow safflower (*Carthamus tinctorius* L.) after harvesting rice as intercrop with garlic, mung bean, cucumber and vegetables in small areas in Phan, Chiang Rai. Office of Agricultural Economics has introduced safflower from India to cultivate in Chomthong, Chaing Mai, since 1983.

Safflower oil, which is obtained from the crushed seed, is very high quality oil to answer the great demand of the local and foreign food and cooking oil and other industries. The residual after the oil is removed is used for animal feed (McGregor, 1967).

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Safflower insect damage is one of the chief limiting factors in efficient safflower production. All available techniques are needed to be evaluated and con – solidated into a unified program to manage safflower pest population in order to obtain higher quality yield and so that economic damage is avoided and adverse side effects on the environment are minimized.

Little work has been done on safflower insects in Thailand. Thongpean (1985) reported that the soil insects, particularly the seed and pod eating ants damaged the safflower seedlings, the boll borers and the aphids injured the plant at flowering stage. Although safflower is slightly more costly to produce, it is still one of the promising cash crops which believed to promote farmer better income.

The objectives of this study have been to obtain the following :

1. Determine the species of safflower insects and their abundances.
2. Determine the safflower key pests and their economic thresholds.
3. Determine the most effectiveness of surveying methods among direct observe method, sweep net catch, and D-Vac machine.

Hopefully, this study will aid in contributing significant informations that may be useful in future safflower insect pest management.

MATERIALS AND METHODS

During the 1986 safflower growing season a qualitative field survey was conducted at two locations : Mae Hia Research Station and Training Center, Chiang Mai (soil type, Nakhon Phanom Aeric Paleaquulth, Clayey mixed) and Wieng Papao, Chiang Rai (soil type, Ban Chong, sandy clay loam).

The total survey area of each location was 1 rai (1,600 m^2) and was divided into 12 plots (10 x 13.3 meters). The safflower variety used was Manjera which was planted with a spacing of 50 x 75 cm on September 18, 1986 at Chiang Mai and on October 20, 1986 at Chiang Rai.

Three methods of surveying had been employed : direct observe method, sweep net catch, and D-Vac machine. Each method was replicated 4 times in a completely randomized design. Safflower insect date were collected on both insect pests and beneficial arthropods. Sampling was begun on October 8, 1986 at Chiang Mai and on November 8, 1986 at Chiang Rai and continue on a weekly basis throughout the growing season. All plots were fertilized with NPK (15-15-15) at the rate of 50 kg per rai when the plants were 4 weeks old. No insecticides were applied in the study area at any time during the safflower growing season.

Direct Observation Method

The total of twenty five plants were selected at random from the middle ten rows in each plot on each sampling date. Safflower insect data were collected by whole plant examination, and recorded on the sampling sheets.

Sweep net catch

The insect net which was made of muslin cloth with 40 cm in diameter and 80 cm deep and with the bamboo handle of 90 cm long was used to collect the safflower insect data in the assigned plots. The investigator walked along the middle ten rows of each plot on each sampling date and swept the net upward throught the top foliage of the plant by using a pendulum swing, swept one stroke per step while walking at a casual pace for the total of 25 sweeps per plot. The collected insect specimens were then transfered into a labeled plastic bag for later laboratory indentification. The number of each species were counted and recorded on the sampling sheet on each sampling date.

D-Vac machine

The vacuum trapping device with the tradename D-Vac, hand model, captures insects by sucking them into a fine mesh net held open inside a rigid enclosure. A portable gosaline motor propels a blower which generate the suctions, was used in collecting the safflower insect data in the assigned plots. The D-Vac was described by Dietrick et al. (1959).

The investigator walked along the middle ten rows of each plot on each sampling date and held the D-Vac sampler head cone horizontally with the plane of the cone at 45 angle toward the row and at a constant half plant height for the total of 25 strokes per plot. The fine mesh net which collected the insects was then removed and labeled for the plot number and date and the insect specimens were kept for later laboratory identification and new fine mesh net was replaced for the next sampling plot. The number of each species were counted and recorded on the sampling sheet on each sampling date.

RESULTS AND DISCUSSION

Safflower Insects and Theirs Seasonal Abundances

From the field observation, one week after sowing, about 20% of the safflower seeds were damaged by the ants and about 15% of the seedlings were damaged by the crickets.

All safflower insect species collected at both experiment fields are given in Table 1. The total of 21 insect pest species (including 3 unidentified species) and 6 beneficial insects (including 3 unidentified species) and various species of the predacious spiders are listed.

The cicadellids *(Thaia oryzivora)* and the aphids (*Myzus* sp.) were the insect pests only collected at Wieng Papao, Chiang Rai, while the aphids (*Uroleucon* sp.) and the rice bugs *(Leptocorisa acuta)* were the insect pests only occurred at Mae Hia Research Station and Training Center, Chiang Mai. The small parasitic wasps, and the unidentified braconids were only detected at Chiang Rai experiment field, while the predacious stink bugs *(Cantheconidea furcellata)* were only occurred at Chiang Mai experiment field.

Table 1. List of safflower insects collected at Mae Hia Research Station and Training Center, Chiang Mai, and Wieng Papao, Chiang Rai, during 1986-1987 growing season.

Insect Classification	Lepidoptera : Liparidae
Insect Pests	Scientific Name
Homoptera : Cicadellidae	*Nephotettix nigropicuts* (Stal)
	Nephotettix virescens Distant
	Thaia oryzivora Ghouri**
	Empoasca sp.
Homoptera : Delphacidae	*Sogatella furcifera* Horvath
Homoptera : Aleyrodidae	*Bemisia tabaci* Gennadius
Homoptera : Aphididae	*Uroleucon* sp.*
	Myzus sp.**
Hemiptera : Pentatomidae	*Nezara viridula* Linnaeus
Hemiptera : Coreidae	*Leptocorisa acuta* Thunberg*
Hemiptera : Miridae	Unidentified species
Orthoptera : Pyrgomorphidae	*Atractomorpha crenulata* Walker
Cloeoptera : Chrysomelidae	*Monolepta signata* Olivier
	Phyllotreta sp.
	Unidentified species
Lepidoptera : Noctuidae	*Spodoptera litura* Fabricius
	Heliothis assulta Guenee
	Heliothis armigera Hubner
	Trichoplusia ni Hubner
	Perigea illecta Walker
	Unidentified species
Beneficial Arthropods	
'Hemiptera : Pentatomidae	*Cantheconidae furcellate* (Wolff)*
Diptera : Syrphidae	Unidentified species
Coleoptera : Coccinellidae	*Monochilus sexmaculatus* (Fabricius)
	Coccinella transversalis (Fabricius)
Coleoptera : Carabidae	Unidentified species
Hymenoptera : Braconidae	Unidentified species **
Araneida :Spiders	Various species

* Insects only collected at Mae Hia Research Station and Training Center,Chiang Mai.

** Insects only collected at Wieng Papao, Chiang Rai.

At Mae Hia Research Station and Training Center, Chiang Mai, the aphids (*Uroleucon* sp.) occurred at the largest average number among all sap sucking insects with approximately 144.64 insects per 100 plants per sampling date. The population of this insect occurred in late vegetative stage and remained high through the late flowering stage. The greatest number was 550 insects per 100 plants which occurred on December 3, 1986. The tobacco whiteflies *(Bemisia tabaci)* were averaged 39.18 insects per 100 plants per sampling date. This insect occurred in mid-vegetative stage through the end of the preflowering stage. The population reached the peak of approximately 175 insects per 100 plants on November 12, 1986, then declined very sharply during the end of the preflowering stage. All other sap sucking insect populations, leaf beetle populations and grasshopper population remained low through the growing season with the average of less than 4 insects per 100 plants. Four leaf-eating Noctuid caterpillars occurred throughout the growing season. The populations of the *Heliothis* complex (including the predominant corn earworms,*Heliothis armigera* and the tobacco budworms, *Heliothis assulta)*, the leaf-feeding noctuids *(Perigea illects)*, and the rice cutworms *(Spodoptera liturs)* were averaged 8.73, 5.91, and 4.45 insects per 100 plants per sampling date, respectively. The ladybird beetle populations (including the predominant species, *Monochilus secmaculatus* and *Coccinella transversalis)* were averaged 5.36 insects per 100 plants per sampling date, and were the highest average number among the beneficial arthropods. These coccinellids occurred throughout the growing season. Other predator populations were averaged less than 3 insects per 100 plants (Table 2 and 3).

At Wieng Papao experiment field, Chiang Rai, the jassids (*Empoasca* sp.) were the most predominant species among all sap suck ing insects collected by D-Vac machine, averaged 96.33 insects per 100 strokes per sampling date. The insects occurred througout the growing season. The population reached its peak of approximately 218 insects per 100 strokes on December 6, 1986 then declined through the latter part of the season. The tobacco whiteflies *(Bemisia tabaci)*, the white-backed planthoppers *(Sogatella furcifera)* and the unidentified mirids were averaged 57.75, 28.33, and 11.75 insects per 100 strokes per sampling date, respectively. All other sap sucking insect populations were averaged less than 3 insects per 100 strokes per sampling date. The largest average population of *Phyllotreta* sp. occurred at the early vegetative stage with approximately 85 insects per 100 strokes on November 8, 1986, then decreased sharply through the latter part of the season. All others leaf beetle populations and grasshopper population remained low through the growing season with the average of less than 4 insects per 100 strokes per sampling date. (Table 6.).

The population of *Perigea illecta* occurred throughout the growing season, averaged 9 insects per 100 plants per sampling date. The greatest number of approximately 27 insects per 100 plants were observed on December 6, 1986, then declined through the later part of the season. All others leaf-eating caterpillars were averaged less than 2 insects per 100 plants (Table 4).

The coccinellid populations (including the predominant species, *Monochilus sexmaculatus* and *Coccinella tranversalis)* were averaged 5.75 insects per 100 plants (Table 4). The spiders (various species) and the unidentified braconids were predominant beneficial species collected by D-Vac machine with the average of approximately 12.58 and 5.17 insects per 100 strokes per sampling date, respectively (Table 6).

Table 2. Safflower insects by direct observe method at Mae Hia Research Station and Training Center, Chiang Mai, 1986 (number per 100 plants).

	October 1986				November 1986				December 1986			
	8	15	22	29	5	12	19	26	3	10	17	Average
	Vegetative stage				Preflowering Stage				Flowering stage			
Insect Pests												
HOMOPTERA												
Nephotettix complex	0	9	10	0	0	1	3	1	0	0	0	2.18
Sogatella furcifera	8	27	0	1	6	0	0	0	0	0	0	3.82
Empoasca sp.	3	7	0	0	3	0	5	0	0	2	0	1.82
Bemisia tabaci	0	0	145	58	24	175	27	2	0	0	0	39.18
Uroleucon sp.	1	0	0	0	120	130	320	250	550	200	20	144.64
HEMIPTERA												
Nezara viridula	0	2	0	1	2	8	0	0	0	0	0	1.18
Unidentified Mirids	0	1	5	0	2	0	1	0	1	0	0	0.91
Leptocorisa acuta	0	0	0	0	0	2	0	2	0	0	0	0.36
ORTHOPTERA												
Atractomorpha crenulate	0	0	0	0	0	0	0	3	0	0	0	0.27
CLOEOPTERA												
Monolepta signata	0	6	0	21	2	0	0	0	0	0	0	2.64
Phyllotreta sp.	0	0	2	1	0	0	11	0	1	1	0	1.45
Unidentified Chrysomelids	3	0	0	0	2	0	0	0	0	0	0	0.45

Table 2. (Continued)

Sampling dates / Growth stage	October 1986				November 1986				December 1986			Average
	8	15	22	29	5	12	19	26	3	10	17	
	Vegetative stage				Preflowering Stage				Flowering stage			
LEPIDOPTERA												
Spodoptera litura	3	12	1	4	8	3	0	11	0	7	0	4.45
Heliothis complex	0	3	30	26	2	2	8	18	6	1	0	8.73
Perigea illecta	0	2	14	3	4	17	12	10	1	2	0	5.91
Trichoplusia ni	0	0	0	1	0	8	0	0	0	0	0	0.82
Unidentified Liparids	0	0	1	1	0	0	0	0	0	0	0	0.18
Benificial Arthropods												
COLEOPTERA												
Coccinellids	1	1	4	5	24	4	6	1	1	12	0	5.36
Unidentified Carabids	1	2	6	3	0	0	1	1	0	0	0	1.27
DIPTERA												
Unidentified Syrphids	0	0	0	0	3	1	0	1	2	4	0	1.00
HEMIPTERA												
Cantheconidea furcellate	0	0	0	0	9	5	3	3	2	2	0	2.18
Spiders												
Various species	3	0	2	2	3	3	8	2	5	3	0	2.82

Table 3. Sefflower insects collected by Sweep net method at Mae Hia Reserch Station and Training Center, Chiang Mai, 1986 (number per 100 sweeps).

Sampling dates / Growth stage	October 1986				November 1986				December 1986			Average
	8	15	22	29	5	12	19	26	3	10	7	
	Vegetative stage				Preflowering stage				Flowering Stage			
Insect Pests												
HOMOPTERA												
Nephotettix complex	1	0	2	0	0	0	1	0	0	0	0	0.36
Sogatella furcifera	2	0	0	0	0	0	0	0	3	0	8	1.18
Empoasca sp.	1	1	2	0	1	2	2	0	0	0	0	0.81
Bemisia tabaci	0	5	0	0	0	0	0	0	0	0	0	0.45
HEMIPTERA												
Nezara viridula	0	0	0	0	0	1	0	0	0	0	0	0.19
Unidentified Mirids	0	0	0	0	2	1	2	16	4	5	1	2.82
ORTHOPTERA												
Atractomorpha crenulate	1	0	3	0	1	1	1	0	0	1	0	0.73
CLOEOPTERA												
Monolepta signata	0	0	0	0	0	1	0	0	0	0	0	0.09
Unidentified Chrysomelids	0	2	2	4	0	0	1	1	0	0	0	0.91
LEPIDOPITERAS												
Spoidiotera kutyra	0	0	0	0	0	0	0	8	0	0	0	0.73
Perigea illecta	0	0	0	0	0	0	1	2	0	0	0	0.27

Table 3. (Continued)

Sampling dates / Growth stage	October 1986				November 1986				December 1986			Average
	8	15	22	29	5	12	19	26	3	10	7	
	Vegetative stage				Preflowering Stage				Flowering Stage			
Beneficial Arthropods												
COLEOPTERA												
Coccinellids	0	0	0	0	0	0	1	1	0	0	0	0.18
Unidentified Carabids	0	0	0	0	0	0	0	0	0	0	1	0.09
Spiders												
Various species	0	0	0	0	3	1	0	6	4	3	0	1.54

Table 4. Safflower insects by direct observe method at Wieng Papao, Chiang Rai, 1986-1987 (number per 100 plants).

Sampling dates	October 1986				Novermber 1986				December 1986				Average
Growth stage	8	15	22	29	6	13	20	27	3	10	7	24	
	Vegetative stage				Preflowering Stage				Flowering Stage				
Insect Pests													
HOMOPTERA													
Nephotettix Complex	0	0	1	1	1	0	0	0	0	0	0	0	1.00
Sogatella furcifera	1	3	0	0	1	0	3	2	0	0	0	0	0.83
Empoasca sp.	0	4	15	6	13	0	1	0	0	1	0	1	3.45
Bemisia tabaci	42	27	62	32	90	8	6	3	0	0	0	0	22.5
Myzus sp.	15	1	6	1	0	0	88	8	0	0	0	0	9.92
HEMIPTERA													
Neazre viridula	0	0	0	0	0	0	1	0	0	0	0	0	0.08
Unidentified Mirids	0	0	0	0	2	1	3	3	2	2	1	1	1.25
ORTHOPTERA													
Artractomorpha crenulata	0	3	1	0	3	3	0	2	1	0	0	1	1.17
COLEOPTERA													
Monolepta signata	4	0	5	2	0	2	0	0	4	9	5	2	2.75
Phyllotreta sp.	2	5	5	4	5	0	2	0	0	0	0	0	1.92
Unidentified Chrysomelids	1	0	0	0	1	0	1	0	1	0	0	0	0.33

Table 4. (Continued)

Sampling dates	October 1986				November 1986				December 1986				
Growth stage	8	15	22	29	6	13	20	27	3	10	17	24	Average
	Vegetative stage				Preflowering Stage				Flowering Stage				
Lepidoptera													
Spodoptera litura	0	0	0	0	1	2	11	4	0	2	0	0	1.67
Heliothis complex	0	0	0	0	0	0	0	5	2	2	0	1	0.83
Perigea illecta	7	5	8	12	27	21	13	7	3	4	1	0	9.00
Trichoplusia ni	0	0	0	1	2	2	0	0	1	0	0	0	0.50
Unidentified Liparids	0	2	0	0	0	0	0	0	1	0	0	0	0.25
Beneficial Arthropods													
COLEOPTERA													
Coccinellids	12	2	0	0	0	0	1	3	17	14	5	5	5.75
Unidentified Carabids	1	2	0	0	0	0	0	0	0	0	0	1	0.25
DIPTERA													
Unidentified Syrphids	0	0	1	0	0	0	0	8	10	2	3	0	2.00
Spiders													
Various species	3	8	5	0	8	5	8	3	3	1	7	1	4.33

Safflower Insect Key Pests

The aphids (*Uroleucon* sp.) and the tobacco whiteflies *(Bemisiatabaci)* were clearly the two predominant species among all sap sucking insects collected at Mae Hia Research Station and Training Center, Chiang Mai. Although their damage to the safflower vegetative partswerenot reached the economic injury level, their ability in plant disease transmission needed to be further investigated. The leaf beetles, the grasshoppers and the leaf-eating caterpillars caused no serious damage to safflower. However, the *Heliothis* complex seemed to be the future key pests due to their ability to destroy the safflower heads. (Table 2 and 3).

At Wieng Papao experiment field, Chiang Rai, there were three predominant sap sucking insects, the jassids (*Empoasca* sp.), the tobacco whiteflies *(Bemisia tabaci)* , and the white-backed planthopper*(Sogatella furcifera)*.Though the damage caused by these insects to the safflower were less evident, their disease transmission ability seemed questionable. The leaf beetles, the grasshoppers, and the leaf-eating caterpillars caused little damage to the safflower vegetative parts. Nevertheless, the *Heliothis* complex had ability to destroy safflower heads and, again, were determined to be the future key pests of the safflower (Table 5,6, and 7).

Safflower Insect Sampling Techniques

Due to the difficulty of the D-Vac machine early in the growing season, safflower insect data collected by D-Vac machine at Mae Hia Reserach Station and Traning Center, Chiang Mai, were incomplete, and had been discarded from the study.

Comparison of the mean for different sampling methods for safflower insect pests and beneficial arthropods at Wieng Papao, Chiang Rai are given in Table 7 and 8.The D-Vac machine was singnificantly the most effcienct method among the three sampling methods employed in collection the small and active sucking insects, the leaf beetles, the braconids and the spiders. Both direct observe method and the sweep net catch were less effective in capturing the small and active sucking insects, the leaf beetles, and the braconids, however, the direct observe method could detect the whiteflies, and the spiders, significantly better than the sweep net catch. The D-Vac machine and the visual search were significantly better in detecting the grasshoppers than the sweep net catch. The direct observe method was the best method for detecting the populations of the safflower caterpillars, the ladybird beetles, and the syrphid maggots.

The level of insect activity is largely a weather response. The weather conditions interact with the insects, thus affect the activity level of the insect being sampled. The efficiency of the sampling method is also affected by weather and the habitat being sampled. Sweep nets are known to be affected by the height and density of the crop and by the vertical distribution of the insects in the crop. Selecting the best method for a specific problem requires through consideration of all available techniques (Southwood, 1966).

Table 5. Safflower insects by direct observe method at Wieng Papao, Chiang Rai, 1986-1987 (number per 100 plants).

Sampling dates	November 1986				December 1986				January 1987				Average
Growth stage	8	15	22	29	6	13	20	27	3	10	7	24	
	Vegetative stage				Preflowering Stage				Flowering Stage				
Insect Pests													
HOMOPTERA													
Nephotettix Complex	1	0	0	5	0	0	0	0	1	0	0	0	0
Sogatella furcifera	4	1	0	0	0	0	0	6	0	0	2	1	58
Empoasca sp.	4	3	1	39	2	4	18	24	5	4	1	27	1.17
Thaia oryzivora	0	0	0	0	0	0	0	0	0	1	0	1	11.00
													0.17
HEMIPTERA													
Unidentified Mirids	0	3	1	0	1	9	7	17	4	10	10	10	6.00
ORTHOPTERA													
Artractomorpha crenulata	3	0	0	0	0	0	0	0	0	3	0	0	0.50
COLEOPTERA													
Monolepta signata	0	1	1	0	2	0	1	2	2	3	4	1	1.42
Phyllotreta sp.	1	0	0	0	0	0	0	0	0	0	0	0	0.08
Unidentified Chrysomelids	3	0	1	6	0	0	1	0	2	0	0	0	1.08

Table 5 (Continued)

Sampling dates / Growth stage	November 1986				December 1986				January 1987				Average
	8	15	22	29	6	13	20	27	3	10	17	24	
	Vegetative stage				Preflowering Stage				Flowering Stage				
LEPIDOPTERA													
Spodoptera litura	0	0	0	3	0	0	2	0	0	3	1	0	0.75
Perigea illecta	0	0	1	0	1	1	0	1	0	0	0	0	0.33
Beneficial Arthropods													
COLEOPTERA													
Coccinellids	1	0	0	0	0	0	0	0	1	0	1	1	0.33
Unidentified Carabids	0	0	0	0	0	0	0	1	0	0	1	0	0.17
HYMENOPTERA													
Unidentified Syrphids	0	0	0	0	0	0	0	0	1	1	1	1	0.33
Spiders													
Various species	1	3	3	7	2	0	0	7	3	0	2	3	2.58

Table 6. Safflower insects by direct observe method at Wieng Papao, Chiang Rai, 1986-1987 (number per 100 plants).

	November 1986				December 1986				January 1987				Average
	8	15	22	29	6	13	20	27	3	10	17	24	
	Vegetative stage				Preflowering Stage				Flowering Stage				
Insect Pests													
HOMOPTERA													
Nephotettix Complex	1	1	1	2	18	0	0	1	0	1	0	0	2.08
Sogatella furcifera	134	0	8	0	0	23	0	9	32	67	40	27	28.33
Empoasca sp.	90	38	68	149	149	170	185	112	78	20	24	4	96.33
Bemisia tabaci	108	70	165	107	107	73	0	0	0	40	45	0	57.75
Thaia oryzivora	2	1	0	0	0	0	0	0	0	1	0	0	0.42
Myzus sp.	0	0	0	0	0	0	0	3	0	0	0	0	0.25
HEMIPTERA													
Unidentified Mirids	5	5	2	9	21	15	18	0	36	16	0	14	11.75
ORTHOPTERA													
Artractomorpha crenulata	1	1	0	3	7	2	2	1	0	0	0	0	1.42
COLEOPTERA													
Monolepta signata	8	2	5	6	1	0	0	3	2	4	6	4	3.42
Phyllotreta sp.	85	12	4	8	0	0	0	0	0	0	0	1	9.17
Unidentified Chrysomelids	2	2	3	4	0	6	2	5	5	0	1	0	2.33

Table 6. (Countinued)

Sampling dates	November 1986				December 1986				January 1987			
Growth stage	8	15	22	29	6	13	20	27	3	10	17	24
	Vegetative stage				Preflowering Stage				Flowering Stage			
LEPIDOPTERA												
Spodoptera litura	0	0	0	0	0	3	0	2	3	0		
Perigea illecta	0	0	0	0	0	5	5	2	0	0		
Beneficial Arthropods												
COLEOPTERA												
Coccinellids	1	3	0	0	0	1	0	0	0	0		
Unidentified Carabids	0	0	0	4	3	1	1	0	2	0		
HYMENOPTERA												
Unidentified Syrphids	28	2	14	0	4	5	2	0	0	0		
Spiders												
Various species	7	18.	12	29	23	12	16	0	23	0		

Table 7. Comparison of the mean for different samplign methods for safflower insect pests at Wieng Papao, Chiang Rai, 1986-1987.

Species	Sampling methods		
	Direct observe	Sweep net	D-Vac
HOMOPTERA			
Nephotettix complex	3.25[a]	1.50[a]	6.25[b]
Sogatella furcifera	2.50[a]	3.75[a]	85.00[b]
Empoasca sp.	10.25[a]	33.00[a]	289.00[b]
Bemisia tabaci	67.50[a]	0.00[b]	170.75[c]
Myzus sp.	29.75[a]	0.00[a]	0.75[a]
HEMIPTERA			
Nezara viridula	0.25[a]	0.00[a]	0.00[a]
Unidentified Mirids	3.75[a]	17.50[ab]	34.00[b]
ORTHOPTERA			
Atractomorpha crenulata	3.50[a]	1.50[b]	3.50[a]
COLEOPTERA			
Monolepta signate	8.25[a]	4.25[a]	10.25[b]
Phyllotrata sp.	5.75[a]	0.00[a]	27.50[b]
Unidentified Chrysomelids	1.00[a]	3.25[a]	7.00[b]
LEPIDOPTERA			
Spodiptera liture	5.00[a]	2.25[a]	2.00[a]
Heliothis complex	2.50[a]	0.00[b]	0.00[b]
Perigea illecta	27.00[a]	1.00[b]	3.00[b]
Trichoplusia ni	1.50[a]	0.00[a]	0.00[a]
Unidentified Liparids	0.75[a]	0.00[b]	0.00[b]

Mean followed by the same letter are not statistically different at the 0.05 level measured by Duncan's multiple range test.

Table 8. Comparison of the mean for different sampling methods for safflower beneficial arthropods at Wieng Papao, Chiang Rai, 1986-1987

Species	Sampling methods		
	Direct observe	Sweep net	D-Vac
COLEOPTERA			
Coccinellids	14.75[a]	1.00[b]	1.25[b]
Unidentified Carabids	0.75[a]	0.50[a]	3.00[a]
DIPTERA			
Unidentified Syrphids	6.00[a]	0.00[a]	0.00[a]
HYMENOPTERA			
Unidentified Braconids	0.00[a]	1.00[b]	15.50[b]
Spiders			
Various species	13.00[a]	7.75[b]	37.75[c]

Mean followed by the same letter are not statistically different at the 0.05 level measured by Duncan's multiple range test.

The use of direct observe method in estimation of insect populations must be approached with caution, because of changes in behavior with the weather and the age of the insects and because of difference among observers in their ability to spot and identify the insect some distance away (Ruesink and Kogan, 1975).

Note : The yields of safflower seeds from the experiments at Mae Hia Research Station and Training Center, Chiang Mai, and Wieng Papao, Chiang Rai, were averaged 66 and 42 kg per rai, respectivety.

References

Dietrick, E.J., Schlinger, E.I., and van den Bosch, R. (1959). A new method for sampling arthropods using a sucking collecting machine and modified Berlese funnel speparator. Econ. Entomol. J. 57 : 719-722.

McGregor, S.E. (1976). Insect pollination of caltivated crop plants. Agricultural Handbook No. 496. Agricultural Research Service, USDA, Washington, D.C.

Reusink, W.G. and Kogan, M. (1975). The quantitative basis of pest management : Sampling and measuring. In: Introduction to Insect Pest Management. Metcalf, R.L. and Luckmann, (eds.). p. 309-351. John Wiley & Sons, Inc., New York.

Southwood, T.R.E. (1966). Ecological methods with particular references to the study of insect populations. Chapman and Hall, Ltd., London.

Thongpean, S.(1985).Safflower. Agricultural Economic news. Office of Agricultural Economics 31 : 8-11. (in Thai).