FIELD EVALUATION OF PREDATORY MITES (*AMBLYSEIUS LONGISPINOSUS*) AGAINST TWO SPOTTED MITES (*TETRANYCHUS URTICAE* KOCH) ON STRAWBERRY

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ABSTRACT

Predatory mites *(Amblyseius longispinosus)* using different release rates (5, 10, 15 and 20 predatory mites/plant) were evaluated against two spotted mites attacking strawberry on the Cordillera. Field trials were conducted in Benguet State University, Balili, La Trinidad from September 2006 to May 2007 and in BPI- BNCRDC , Guisad, Baguio City from October 2007 to May 2008.

Predatory mites during the first trial was released January 2007 with initial TSM population of 0.27 – 7.93 adult/leaflet. Released predator started reproducing 1 -2 weeks after field release and peak of population occurred 8 WAR for both eggs (28.33 per leaflet) and active stages (15.33 – 35 per leaflet).

Single release predatory mites started decreasing two spotted mites population 5 – 6 weeks after release and population from plots released with 20 – 20 PM/plant were significantly lower than the plots released with 5 PM/plant. Predatory mites were also counted from the controls 2 – 3 WAR and peaked 7 – 8 WAR.

Total marketable berries from the released plots were higher than the released plots. Peak of harvest was recorded 5 WAR and an average of 1,008.33 – 1,175 g/plot was harvested from the released plots and 643.33g/plot from the control plots. Marketable berries decreased 6 – 11 WAR in all treatment plots because of damaged fruits mostly caused thrips,snails an also Lygus bugs.

For the second trial, the predatory mites multiplies after field release and peak of population for both eggs and active stages was observed 4 – 5 weeks after PM release with an average 22 – 44 eggs and 20 – 43 active stages per strawberry leaflet. More predators were counted from higher release rates following 3 field releases. Predatory mites were also monitored from control plots 3 WAR and population increase the following weeks.

Two spotted mites population started decreasing 3 WAR and continuous feeding or predatory mites to almost zero population (0.07 – 0/93 TSM/leaflet) 6 to 7 weeks after PM releases. Three field releases and higher release rates (10 – 20 PM/plant) resulted to lower TSM population earlier than the other treatments.

INTRODUCTION

Strawberry is a high valued fruit crop in the Cordillera particularly in Benguet Province. This fruit crop is successfully being grown in the locality. However, there are several factors limiting production.

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Two spotted mites (*Tetranychus articae* Koch, Acarina: Tetranyhidae) is one of the major factor limiting production in most growing areas. Field infestation usually starts during the onset of dry season and if not controlled earlier, population becomes severed starting January when plants are mostly flowering and fruiting. Infestation during this period, if not controlled, results to poor production.

Spider mites are usually controlled using different pesticides, however, these chemicals have several side effects to human and the environment and even very expensive. The pest also easily develops resistance to the chemicals commonly used thus contributing to a more difficult management of the pest. Biological control which is one of the environment-friendly measures is therefore being considered for better strawberry production in the area.

Preparatory mite is a promising biological agent in the locality. Different activities are presently being conducted by concerned agencies/institutions (BSU,BPI, OPAG, OMAG) to develop technologies on the mass production and field application of the predator. This study was therefore conducted to observe p[predatory mites in the field and f=determine their effect on two spotted mites. This information will help in the development of integrated control on TSM for better strawberry production ion the locality.

REVIEW OF LITERATURE

Different natural enemies were reported against TSM and these include phytoseiids and predatory insects like *Stethorus spp.* (ladybird beetles), *Mircromus spp.* (lacewing), *Scolothrips sexmaculatus* (Pergard) or the six-spotted thrips *Septothrips mali* (Fitch) or the black hunter thrips *Geocoris punctipes* and *Orius trriscolor* (White). Predatory mites and other predators do not totally eradicate TSM population but they prevent it from increasing to a level which could cause economic damage. For better development and establishment, predators could be enhances by restricting frequency of pesticide sprays and using pesticides with lower toxicity (Pimentel, 1984, Swaine **et al.**, Hely **et al.**, 1982; Broadley **et al** 1988)

In the Philippines, Raros (1986) reported that phytoseiid mites in the country mostly belong to three genera `: Genus *Phytosius*, Genus *Typhlodomus* and Genus *Amnlyseius.* The most common species is the *Amblyseius largoensis Muma* which was ound in almost all plants examined for plkant mites and *Amblyseuis longispinosus* (Evans) which was noted to be commonly associated with spider mites and flat mites.

In the Cordillera, eight species were reported and two species, *Amblyseuis longispinosus* (Evans) and *Typhlodomus flechneri* Chant, were particularly recorded on Benguet (Raros, 1986).

For predatory mites, success depends on the release rates, time of release and the introduction and monitoring activity. Recommendation the release rates of predatory mites are usually based on the different factors such as the area of the land (per square meter or per acre/hectare), the number of plants (per plant) or the number of two spotted mites.

For *Phytoseliulus persimilis* Athias-Henriout, Broadley **et al.** (1988) recommend two predatory to be released per strawberry plant. He stated that releasing more than two gives not much benefits. Pimentel (1981) also reported that releasing 300,000 *P. persimilis* per acre before spider mites reach one per leaf provides effective control.

In Taiwan, Lo **et al.** (1990) reported that spider mites have lower population on blocks released with 20- and 10 *Amblyseuis spp.* per plant and were significantly lower than those inoculated with 2 to 5 mites per plant.

Stetseth (1987) mentioned that the introduction of *P. persimilis* on every 2 square meters of chrysanthemum plants give satisfactory control of red spider mites at an average of below 2 spider mites per leaf. He also cited that in United Kingdom, they use one predatory mite per 10 cuttings within 2 to 3 weeks of planting.

To have an effective control of spider mites, predatory mites should be released at the correct time and at suitable inoculation levels. According to Brough **et al. (1994),** the release of predatory mites like the *Phytoseiulus persimilis* Agfhias-Henriout is recommended when there are six spiders per leaf. For better TSM control, he further recommended that releasing of spider mites should be done when the spider mites or the prey are present because predatory mites may either starve or leave the crop if the prey is not present. They could also be released anytime of the day but not during or when there is heavy rain. If needed irrigate plant before releasing and stop at least three days after release to avoid drowning of predatory mites and their eggs.

OBJECTIVES

The study was conducted to evaluate the predatory mites, *Amblyseius longispinosus* against two spotted mites attacking strawberry.

Specific Objectives:

Trial I

1. To observe field released predatory mites.
2. To determine the effect if predatory mites on two spotted miters.
3. To determine the effective release rates under natural infestation.
4. To observe other pest affecting strawberry while using predatory mites.

Trial II

1. To observe field released predatory mites.
2. To determine the effect of field released predatory mites on two spotted mites.
3. To determine the effective release rates under natural infestation.
4. To determine the effect of different field releases.
5. Top observe other pest affecting strawberry while using predatory mites.

METHODOLOGY

Field Trial- Two field trials were conducted to evaluate the predatory mites. These were conducted at BSU, Balili, La Trinidad, Benguet and BPI, Guisad, Baguio City.

Study 1 – First trial was conducted at the BSU Experimental area in Balili, La Trinidad, Benguet. Strawberry runners using the Sweet Charlies variety were planted on 1 x 12 meters plot mulched with black plastic. The double row method was used and runners were planted 40 cm between hills and 40 cm between rows. The strawberry plants were maintained following the necessary cultural management practices. Pesticide was not used to have better establishment of two spotted mites.

Study II – This was conducted to further evaluate results during the first trial. This was conducted at the BNCRDC Research area in Guisad, Baguio City. Strawberry runners using the Sweet Charlies variety were planted ion 1 x 5meters plot mulched with black plastic. The double row method was used and runners were planted 30 cm between hills and 30 cm between rows. The strawberry plants were maintained following the necessary cultural management practices. Pesticide was not used to have better establishment of two spotted mites.

Monitoring of Mites Population – Monitoring of two spotted mites started one month after planting predatory mites were released when average count of adult two spotted mites was 2 – 8 TSM per strawberry leaflet.

Trial 1, six (6) plant were marked as sample plants per treatment plot 1 x 12 sq.m and these were spaced every after the fifth plant. Based on the results of the first trial, the sample plant for the second trial were increased. Five (5) plants was sampled per treatment plot measuring 1 by 5 sq. m an these were marked every after the 4th plant.

Treatment – The adult predatory mites were released on the plant using the following rates.

Treatments	Release rates
T_0	Control (No predatory mites)
T_1	5 predatory mites
T_2	10 predatory mites per plant
T_3	15 predatory mites per plant
T_4	20 predatory mites per plant

Number of field release- Single release was done during the first trial. However, for the second trial, follow-up releases was tried to augment initial release. The area was divided into two blocks. Initial release on both blocks was done at the same time and follow-up releases were done after one week.

Block I – 2 field releases of PM (initial release + 1 weekly follow-up release)

Block II – 3 field releases of PM (initial release + 2 weekly follow-up releases)

After releasing the predatory mites, weekly population of both predatory mites and two spotted mites were counted following the destructive sampling method. Lower leaf of sample plants per treatment replication were sampled. Collected leaves were brought to the laboratory and mites were counted using stereomicroscope.

Data Gathered

1. Population of mites – Weekly population of both two spotted mites and the predatory mites was counted from 1 sample leaf (lower leaf) collected per sample plants. Samples leaves were placed in plastic containers/bags and mites were counted in the laboratory using stereomicroscope.

1. Yield (kg.) of strawberry - Berries were harvested twice a week and the marketable and non marketable berries were recorded. Berries of assorted size weighing 10 -50g/fruit with normal color and shape were classified during the study as marketable. Small berries weighting below 10 grams and fruits with abnormal shape or color regardless of size were considered non-marketable or culls. Berries showing mites damage were separately weighed from the non marketable.
2. Other pests associated with strawberry – Aside from two spotted mites, other pests affecting the strawberry plants were also monitored in offer to know what other pests needs to be managed when using predatory mites.

RESULTS AND DISCUSSSION

Trial 1

Population of predatory mites - Predatory mites were released in the field January 2007 with initial two spotted spider mites (TSSM) population of 0.27 to 7.93 TSSM/leaflet. Weekly population was monitored and results show that the releases predatory mites multiplies after the field release.

Eggs. Eggs of the predatory mite were counted from the released lots one week after the release and an initial count of 0.33 to 23.33 eggs were counted per leaflet (Table 1). The number abruptly increased to 9.67 – 13.67/lrsaflet 5 weeks after release and 17.67 – 29.00/lewflet 6 weeks after the release.

Eggs were also counted from random/unreleased plant 1 week after the release and from the control plant 2 -3 weeks after the release. Eggs counted from plots released with 10 predatory mites/plant were higher compared to the other released plots. Presence of eggs on the unreleased plant/plot indicates that the released adults migrated after the release and they could migrate 40 – 100 cm from the released plant/site.

Active and adult stages – Some of the released adults were recovered from the released and unreleased plants 1 -2 weeks after the field release and immature stages were counted 3 – 4 weeks after field release (Table 2). Population abruptly increased 6 weeks after release and an average of 11.33 – 20.00 active stages/leaflet were counted from released plants and 7.67 – 29.00leaflet from unreleased or random plants Population continuously

increased in all treatment plots and more predators were counted from plots released with 10 predators/plant 8 – 9 weeks after the release.

Presence of predators on random and control plant shows that the predator could disperse 40 – 100 cm from the released plants. Higher population on plots released with lower rates could also be due to movement of adults from nearby plot of higher predator population. Studies show that predatory mites usually disperse to search for their prey. Female also disperse during oviposition and once they are established, they actively feed on their prey and start reproducing (Heller and Cabalism, 1985 and www.redlandnursery.com.au/infogeneral/mites.htm).

Table 1. Average weekly count of eggs of predatory mites *(Amblyseia longispinosus)* after field release (January to April 2007)

	Weeks after PM release								
Release Rates	1 Jan 26	2 Feb 2	3 Feb 9	4 Feb 16	5 Feb 22	6 Mar 2	7 Mar 9	8 Mar 15	9 Mar 23
Release plants									
No PM	-	0.67	0.33	1.0b	2.33	5.33	8.00	18.33	17.33
5 PM/plt	0.67	1.67	0.67	2.0a	9.67	19.00	15.67	29.67	38.67
10 PM/plt	1.33	1.33	5.00	3.67a	12.67	29.00	23.33	31.67	28.00
15 PM/plt	1.00	1.00	5.00	3.33a	13.67	17.67	22.67	29.33	24.00
20 PM/plt	2.33	2.33	1.33	4.67a	11.67	20.33	30.00	32.67	29.67
Random plants									
No PM	-	-	0.67	0.33	1.67	2.67	4.33	9.33	14.67
5 PM/plt	0.67	0.67	1.00	1.00	8.33	9.33	11.67	28.33	18.00
10 PM/plt	0.33	0.33	2.67	2.67	12	23.00	27.33	33.00	30.33
15 PM/plt	1.00	1.00	2.67	2.67	9.67	14.67	18.33	27.00	23.67
20 PM/plt	0.67	0.67	2.00	2.00	10.67	16.00	30.67	35.33	25.33

Average of 5 sample leaves from released and random plants/ treatment replication.
5 Plants released with predatory mites
5 Sample plants randomly selected per treatment replication

Table 2. Average weekly count of immature and adult stages of predatory mites *(Amblyseia spp)* after field (January to April 2007)

Release Rate	1 Jan 26	2 Feb 2	3 Feb 9	4 Feb 16	5 Feb 22	6 Mar 2	7 Mar 9	8 Mar 15	9 Mar 23
	Weeks after PM release								
Release plants									
No PM	-	0.67	-	0.67	1.00	2.33	4.33	12.00	15.67
5 PM/plt	1.67	1.67	1.00	2.00	4.67	11.33	9	15.33	26.00
10 PM/plt	4.33	4.00	1.67	2.67	9.00	20.00	19	25.67	31.67
15 PM/plt	0.33	0.33	2.33	4.33	10.33	13.67	15	22.00	30.00
20 PM/plt	3.33	3.00	2.67	6.00	9.67	14.67	22.67	26.67	25.33
Random plants									
No PM	-	-	-	-	1.67	2.00	4.67	16.33	18.67
5 PM/plt	0.67	0.67	-	0.33	5.33	7.67	8.33	35.00	34.33
10 PM/plt	0.67	0.67	0.67	0.67	8.67	10.00	13.00	32.67	30.33
15 PM/plt	0.33	1.00	-	0.67	9.33	11.67	17.00	23.00	28.67
20 PM/plt	2.67	1.33	1.33	1.33	4.67	29.00	15.67	27.67	29.67

Average of 5 sample leaves of released and random plants/ treatment replication.
5 Plants released with different release rates predatory mites
5 Sample plants randomly selected per treatment replication

Population of TSM.

The population of immature and adult TSM from all treatment plots continuously increased for six weeks after the release (Table 3). However, population from the released plots was lower than the population from the control plots. Highest population were observed 6 weeks after the release of predatory mites and slightly decreased the following weeks. Population from the plants released with 10 - 20 PM/plant were significantly lower 7 – 9 weeks after the release of predatory mites.

Result shows that the released predatory mites affected TSM population in the field. Lower TSM population from plots released with 10 - 20 PM/plant indicates

that higher PM population is needed for better and faster control of TSM population.

Table 3. Average weekly count of immature and adult stages two spotted mites *(Tetranychus urticae* Koch) on strawberry before and after the release of predatory mites *(Amblyseius* spp. From Jan to April 2007

Release Rates	Initial pop'n	1 Jan 26	2 Feb 2	3 Feb 9	4 Feb 16	5 Feb 22	6 Mar 2	7 Mar 9	8 Mar 15	9 Mar 23
Release plants										
No PM	6	9.53	6.6	14.27	15.93	35.6	44.60a	59.53a	43.53a	29.27a
5 PM/plt	3.13	6.87	4.8	5.07	10.6	17.67	29.20ab	27.3ab	28.80ab	21.07ab
10 PM/pl	7.93	5.73	5.8	5.06	8.87	17.33	22.80b	22.80b	17.67b	1.87c
15 PM/pl	0.27	5.67	2.07	7.0	6.93	21.37	28.33ab	28.33ab	14.33b	17.87ab
20 PM/pl	3.54	5.93	2.4	9.87	7.53	19.57	16.20	15b	19.33b	5.33b
Random plants										
No PM	1.2	14.07	7.2	20.4	12.6	37.33	45.00a	55.33a	33.27a	20
5 PM/plt	5.53	13.33	8.2	15.87	13.33	19.83	33.67ab	31ab	23.40ab	21
10 PM/pl	3.6	17.33	8	16.6	19.87	15.67	28.33ab	33.67ab	9.73b	13.6
15 PM/pl	2.73	15.27	7.27	20.07	7.67	22.17	42.33ab	32.67ab	17.47ab	16.27
20 PM/pl	0.6	13.87	6.2	16.73	10.53	13.83	24.73c	20.67b	10.67.	14.6

Average of 5 sample leaves of released and random plants/ treatment replication.
5 Plants released with different release rates predatory mites
5 Sample plants randomly selected per treatment replication

Marketable berries.

An average of 414.33 – 1037.33g marketable berries were initially harvested per plot and peak of harvest was recorded 5 weeks after the release of predatory mites (Table 4). An average of 1,008.33 – 1,175g/plot was harvested from released plots and 643.33g from the control plot. The weight of marketable berries continuously decreased 6 – 11 weeks after the predatory mite release.

Decreasing TSSM population during the period could be due to infestation of thrips and Lygus bugs which was first observed 4 weeks after the field release (Table 5)

Table 4. Mean weight (g) of marketable strawberries harvested from January to March 2007

	WEEKS AFTER PREDATORY MITES RELEASE											
RELEASE RATES	20 Jan	1 26 Jan	2 2 Feb	3 9 Feb	4 16 Feb	5 22 Feb	6 2 Mar	7 9 Mar	8 16 Mar	9 23 Mar	10 30 Mar	11 6 Apr
No PM	511.33	537.17	433.33	516.67	545.00	643.33	616.67	661.67	518.33	400.00	466.67	270.00
5 PM/plt	414.33	540.00	465.33	533.33	685.00	1,133.33	833.33	833.33	936.67	650.00	566.67	300.00
10 PM/plt	891.67	843.50	519.67	558.33	783.33	1,123.33	966.67	966.67	966.67	766.67	550.00	400.00
15 PM/plt	542.00	541.33	443.20	675.00	790.00	1,175.00	766.67	766.67	673.33	666.67	516.67	340.00
20 PM/plt	1,037.33	794.17	492.80	619.00	691.00	1,008.33	8.00.00	800.00	800.00	916.67	633.33	363.33

Table 5. Mean weight (g) of marketable strawberries harvested from January to March 2007

	WEEKS AFTER PREDATORY MITES RELEASE										
Small/deformed/damaged by other insects											
RELEASE RATES	1 26 Jan	2 2 Feb	3 9 Feb	4 16 Feb	5 22 Feb	6 2 Mar	7 9 Mar	8 16 Mar	9 23 Mar	10 30 Mar	11 6 Apr
No PM	64.83	126.67	189.67	127.33	209.33	233.33	216.67	375.00	250a	293.33	275.00
5 PM/pl	43.83	110.43	77.00	106.33	180.33	206.67	166.67	266.67	166.67b	210.00	206.67
10 PM/plt	74.00	127.77	171.33	116.67	193.33	190.00	191.67	283.33	193.33ab	206.67	180.00
15 PM/plt	70.50	128.70	117.33	106.33	175.33	171.67	190.00	266.67	143.33b	233.33	233.33
20 PM/plt	92.83	120.83	161.00	127.33	189.67	190.00	156.67	258.33	141.67b	183.33	200.00

Damaged by mites and thrips

RELEASE RATES	1 26 Jan	2 2 Feb	3 9 Feb	4 16 Feb	5 22 Feb	6 2 Mar	7 9 Mar	8 16 Mar	9 23 Mar	10 30 Mar	11 6 Apr
No PM			87.00	94.00	193.67	216.67	150.a	233.33a	71.67	233.33a	126.67
5 PM/plt			73.33	91.67	108.00	112.00	100b	159.67b	76.67	175ab	116.67
10 PM/plt			65.17	88.33	90.17	101.67	106.67ab	95.00c	33.33	110b	73.33
15 PM/plt			53.17	63.00	110.17	105.00	70.00b	91.00c	44.33	128.33b	61.67
20 PM/plt			79.33	85.00	125.00	84.67	76.33b	104.00c	45.00	133.33b	78.33

Trial II

1. Average population of predatory mites

Predatory mites were initially released in the field February 22, 2008 when TSM infestation was monitored. Weekly population was counted and results show that the predatory mites survive after field release as shown in Table 69.

1.a. Average population of active stages of predatory mites

Two field release. An average of 0.25 to 1.25 adult predatory mites was observed just after field release (Table 6). Population increased and peak of population occurred 4 WAR on plots released with in 15 and 20 PM/plant and 5 WAR for the other released plots. From an average population of 23.50 – 33.75 PM/leaflet 5 WAR, population from released plots abruptly decreased by 82 – 87% 6 WAR (3.25 – 7.0 PM/leaflet) and were comparable to control plots 6 WAR but significantly lower 7 WAR.

Some predatory mites were counted from the plots 3 WAR (0.50 PM/leaflet. Population increased the following weeks and was significantly higher (9.75) Pm/leaflet) than the released plots 7 WAR.

Three field releases. Table 7 shows that an average of 0.50 – 1.75 Pm/leaflet) was counted from released plots 1 WA. Population continuously increased for 4 weeks and population from plots released 20 PM/plant had its peak 4 WAR and 5 WAR for the other released plots including the control plots. Predatory mites from released with 15 and 20 PM/plant were comparably higher that the other released plots 1 – 5 WAR.

Population of predatory mites from released plots greatly decreased 6 WAR from 28.25 – 40.25 to 2.00 – 3.75 PM/leaflet 6 WAR and 0.50 – 1PM/leaflet 7 WAR and were significantly lower compared to PM population from the control plots.

The increasing number active stages of predatory mites after releases show that the released predatory mites survived in the field and started reproducing just after the release. Higher population observed from plots with more population of PM and higher release rates show more predator results to higher population after release this more predator to feed on TSM.

Abrupt decrease in PM population from released plots as noted 6 – 7 WAR could be due to lower TSM population. They moved or dispersed to other plants or plots to search for more TSM food. This movement could explain the higher number of predators from plots release with lower rates during the later period of monitoring and also the presence of predatory mites in control plots 3 – 7 WAR. Predatory mites possibly dispersed to search for their prey on the plants or plots with higher TSM population.

Table 6. Summary table on the average number of active stages predatory mites after 2 PM releases

PM Release	WEEKS AFTER PM RELEASE (WAR)						
	1	2	3	4	5	6	7
No. PM	0.00	0.00	0.50b	3.50c	6.25b	8.00a	9.75a
5	0.50	6.50	10.50a	20.00b	23.50a	4.25ab	3.25b
10	0.25	3.00	9.25a	24.50ab	25.75a	3.25b	2.25b
15	0.75	6.25	13.00a	33.25ab	33.00a	5.00ab	2.00b
20	1.25	5.00	11.50a	38.00a	33.75a	7.00ab	2.25b

Table 6. Summary table on the average number of active stages of predatory mites after 3 PM releases

PM Release	WEEKS AFTER PM RELEASE (WAR)						
	1	2	3	4	5	6	7
No. PM	0.00	0.00	2.00c	4.75d	17.50c	15.75a	3.25a
5	0.75	3.25	12.25b	23.25c	28.25b	3.75b	1.0b
10	0.50	6.00	12.00b	28.25bc	32.25b	3.50b	0.75b
15	0.75	5.25	16.50a	73.00ab	40.25a	2.00b	0.50b
20	1.75	10.50	19.50a	43.75a	39.25a	2.25b	0.50b

1.b. Average number of eggs of predatory mites

Two field release. Eggs of predatory mites were monitored from the released plots 2 WAR 98.25 – 11 eggs/leaflet) as show in Table 8. Number increased for 2 weeks and plots released with 20 PM/plant had the highest number of eggs 4 WAR but was comparable with plots released with 15 PM/plant. Number of eggs decreased 6 – 7 WAR and eggs from released plots were lower compared to the control plots.

Three field releases. An average of 0.75 0 1.50 eggs/leaflet were counted 1 WAR (Table 9). Number increased to an average of 23 – 44 per leaflet 4 WAR and plots released eggs/leaflet). Number of eggs decreased 5 WAR and plots released with 10 – 20 PM/plant had significantly lower number of eggs than the other released and control plots. Number of eggs continuously decreased and number counted from released plots which ranged from 1.50 – 2.75 eggs/leaflet 6 WAR and 0.05 – 1.25 eggs/leaflet 7 WAR were significantly lower compared to the control plots. Eggs were also deposited on the control plants and 2.50eggs/leaflet counted 3 WAR and increased to 17/leaflet 5 WAR. Number decreased to 14.50 eggs plant 6 WAR and 6.25 at 7 WAR however, number were still significantly high compared to the released plots.

The eggs of PM counted from the different released and control plots were closely related to the number of adults counted. More eggs were counted at higher adult PM population.

Table 8. Summary table on the average number of eggs of predatory mites after 2 field releases

PM Release	WEEKS AFTER PM RELEASE (WAR)						
	1	2	3	4	5	6	7
No. PM	0.00	0.00	0.00	7.00c	14.75	11.25a	13.75a
5	0.00	8.25	7.50	22.25b	13.25	3.50b	2.00b
10	0.00	11.00	12.25	25.00b	10.25	2.50b	1.25b
15	0.00	9.00	10.75	39.00ab	21.50	5.25b	1.50b
20	0.00	9.75	14.50	43.75a	22.75	4.50b	1.25b

Table 9. Summary table on the average of eggs of predatory mites after 3 field releases

PM Release	WEEKS AFTER PM RELEASE (WAR)						
	1	2	3	4	5	6	7
No. PM	0.00	0.00	2.50c	11.75c	11.00a	14.50a	6.25a
5	0.75	7.00b	10.00b	26.00b	8.75b	2.75b	1.25b
10	1.00	13.00a	13.75b	23.50b	3.25c	1.50b	1.00b
15	0.75	15.75a	13.25b	44.00a	2.00c	2.00b	1.25b
20	1.50	13.25a	23.50a	43.25a	4.00c	1.50b	0.05b

1. Average population of active of TSM

The population of predatory mites before and after releases of predatory mites is shown in Table 10 and 11.

Two field releases. From an initial population of 2.07 – 2.57 TSM/leaflet, TSM population from all treatment plots greatly increased 1 WAR by 88 – 92% (20.57 – 28.36 TSM/leaflet) and peak of population occurred 2 WAR including the control plots. After two weekly release of predatory mites, population decreased the following weeks in all treatment plots however, results from released plots were significantly low compared to the control plots (Table 10).

For the released plots, TSM population of 17.11 – 19.35 TSM/leaflet 3 WAR decreased to 2.15 – 3.11 5 WAR and almost 6 – 7 WAR (0.07 – 1.18 TSM/leaflet). Population from plots released with 20 PM/plant was generally low compared to the other released plots.

Three field releases. Peak of TSM population also occurred 2 WAR and population from released plots was significantly lower than the control (Table 11). TSM started decreasing 3 WAR and population of 15.25 – 17.79 TSM/leaflet from plots released with 10 – 20 PM/plant significantly decreased to an average of 2.68 – 4.95 TSM/leaflet 4 WAR. Population from all released plants ranged from 0.15 - .93 TSM/leaflet 6 – 7 WAR and was lower compared to control plots.

Trend of TSM population from plots released 2 – 3 times with predatory mites was almost the same however, TSM population is lower and is reduced earlier with 3 field releases. Results show that the released predatory mites starts feeding 2 WAR as shown by the lower TSM on released plots and continuous feeding significantly reduced TSM population to an average of 2 – 5 WAR and almost zero 6 – 7 WAR depending on the number and rate of PM release.

For control plots, decreased in TSM population starting 3 WAR and very low population 6 – 7 WAR is attributed to the predatory mites monitored during the period on the said plots. The predator dispersed from nearby released plots. This shows that the predator has high dispersal or searching ability and is dependent on TSM population. So without TSM, the predator may die or disperse to search for food.

Table 10. Summary table on the average number of active stages of two spotted mites after 2 PM release.

PM Release	WEEKS AFTER PM RELEASE (WAR)							
	Initial pop	1	2	3	4	5	6	7
No. PM	2.32	28.36	49.91	38.75a	27.55a	13.78a	6.89a	1.18a
5	2.07	25.13	37.28	18.64b	12.85b	2.96b	0.87b	0.07b
10	2.57	20.68	35.79	17.89b	10.69b	3.11b	0.68b	0.29b
15	2.21	22.04	38.70	19.37b	11.21b	2.48b	0.71b	0.14b
20	2.50	20.57	34.23	17.11b	10.94b	2.15b	0.41b	0.21b

Table 11. Summary table on the average number of active stages of two spotted mites after 3 PM release.

PM Release	WEEKS AFTER PM RELEASE (WAR)							
	Initial pop	1	2	3	4	5	6	7
No. PM	2.43	30.8a	66.55a	39.96a	20.58a	9.50a	3.23a	2.1a
5	2.2	25.73a	43.04b	21.52b	14.17b	4.12a	0.93a	0.4b
10	2.5	25.18a	33.85b	16.93b	4.95c	3.76a	0.74a	0.57b
15	2.43	23.89b	30.50b	15.25b	4.37c	4.63a	0.57a	0.25b
20	2.29	21.55b	35.58b	17.79b	2.30d	2.30a	0.5a	0.15b

1. Average weight of marketable berries.

Harvesting of berries 4 weeks before the release of predatory mites. An average of 120 – 197 g berries per treatment plot was harvested and continuously increased for 4 weeks (Table 12 – 13). Harvested berries from all treatment plots decreased the following weeks and harvest were not stable because of continuous rain which caused fruit rot on matured and developing fruits. However, marketable berries are still higher on released plots.

5. Average weight of non marketable berries

Weight of non marketable berries sorted during weekly harvest is shown in Table 9 – 10. Berries considered as non marketable were mostly due to fruit rots and some damaged berries due to caterpillar and slugs. Damage of two spotted mites on berries was not severe during the study probably because TSM population was reduced earlier. Although TSM population was high 1 -3 weeks after predatory mites were released however, TSM were mostly on lower leaves, thus shoots and developing flowers/fruits were not severely affected.

Table 12. Summary table on the average weight (g) of marketable berries from plots with predatory mites two times.

PM release	WEEKLY HARVEST											
Rates	1	2	3	4	5	6	7	8	9	10	11	12
No. PM	130.00b	337.50c	450.00	487.50c	675.00	590.00	497.50b	438.75b	305.00b	368.75	312.50b	188.75b
5	127.50b	445.00ab	575.00	582.50a	815.00	732.50	617.50a	575.00a	437.50a	515.50	393.75b	276.25.a
10	155.00ab	365.00bc	500.00	515.00a	705.00	617.50	502.50a	637.50a	472.50a	573.75	390.00b	251.25a
15	150.00ab	470.00a	590.00	732.50a	772.50	747.50	622.50a	605.00a	627.50a	716.25	673.75a	361.25a
20	227.50a	395.00abc	597.50	672.50a	737.50	727.50	660.00a	536.50a	560.00a	477.50	402.50a	265.00a

Table 13. Summary table on the average weight (g) of marketable berries from plots with predatory mites two times.

PM release	WEEKLY HARVEST											
Rates	1	2	3	4	5	6	7	8	9	10	11	12
No. PM	197.50	402.50	365.00	675.00	753.75	655.00	476.25	668.75	445.00	567.50	397.50	216.26b
5	165.00	377.50	577.50	642.50	740.00	650.00	442.50	547.50	477.50	677.50	475.00	253.75b
10	120.00	365.00	527.50	637.50	675.00	642.50	448.75	561.25	487.50	651.25	391.25	245.00b
15	150.00	380.00	525.00	600.00	795.00	647.50	557.50	702.50	517.50	656.25	448.75	302.50ab
20	162.50	417.50	572.50	630.00	857.50	795.00	542.50	692.50	612.50	710.00	576.25	413.75a

Table 14. Summary table on the average weight (g) of non marketable berries from plots released with predatory mites two times.

PM release	WEEKLY HARVEST											
Rates	1	2	3	4	5	6	7	8	9	10	11	12
No. PM	16.25	20.00	37.50	36.25	85.00	152.50	231.25	217.50	335.00	297.50	491.25	220.00
5	15.00	30.00	15.00	22.50	56.75	102.50	200.00	178.75	270.00	266.25	495.00	270.00
10	5.00	30.00	36.25	22.50	30.00	90.00	137.50	67.50	287.50	247.50	597.50	278.75
5	8.75	30.00	31.25	11.25	60.00	146.25	275.75	158.75	312.	245.00	373.75	225.00
0	11.25	50.00	25.00	11.50	48.75	135.00	221.25	132.50	315.00	270.00	478.75	308.75

Table 15. Summary table on the average weight (g) of non marketable berries from plots released with predatory mites three times.

PM release	WEEKLY HARVEST											
Rates	1	2	3	4	5	6	7	8	9	10	11	12
No. PM	2.50	58.75	58.75	47.50	82.50	147.50	242.50	177.50	270.00	202.50	360.00	200.00
5	10.00	46.25	26.25	28.75	78.75	142.50	327.50	121.25	247.50	191.25	387.50	251.25
10	15.00	56.25	27.50	46.25	67.50	150.0	267.50	161.25	237.50	228.75	358.75	251.25
15	11.25	47.50	46.25	38.75	60.00	120.00	292.50	221.25	292.50	253.75	575.00	267.50
20	20.00	28.75	43.75	22.50	77.50	142.50	315.00	115.00	272.50	280.00	401.25	302.50

5. Other pests of strawberry.

Aside from the spotted mites, different pests were observed associated with strawberry Table 16). Cutworm and white grubs of June beetle and snoutbeetle were noted during the establishment and vegetative stage. Cluster caterpillars were noted on the leaves starting January and these affected the shoots, flowers and developing fruits. High population of thrips (20 – 40 per sample flower) during the early flowering and fruiting stage was monitored however, damage did not severely affect the fruits probably because of continuous rain experienced end of February to March.

Table 16. Common pests observed on strawberry plants released with predatory mites

COMMON PESTS OBSERVED	OBSERVED DAMAGE	MONTHS						
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Grubs of Snoutbeetle	Feeds on roots of newly established plants. Causes wilting and death of plants							
Grubs of june beetle	Total feeding on the roots of young and established plants.			—	—			
Slugs/snails	Causes holes on the fruits			—	—	—	—	
Cutworms	Feed root or part just above the soil. Also feeds on the young shoots and leaves.		—	—	—			
Different Caterpillars	Attacks the leaves, shoots, flowers and fruits. Feeding causes drying of leaves and holes on the fruits.			—	—	—	—	—
Lygus bug	Feeds on the fruits.				—	—		
Leaf beetle	Feeding causes holes on the leaves.							
Thrips	Causes major damage on the fruits. Infestation occurs almost the same with mites and causes almost the same symptoms. Infestation starts during the flowering period until the end of fruiting.			—	—	—	—	—

CONCLUSION

Results shows that the predatory mites, *Ambleseius longispinosus*, could survive in the field and can start multiplying 1 – 2 weeks after field release.

First trial shows that the predatory mites had reduced TSM population however, the period or time of decreasing the pest to zero or very low was long. This could be due to the movement of the pest during the release thus higher population was still observed.

Higher population of predatory mites mean faster reduction of the pest so higher rates will be use at higher pest population.

For better control of this study, more releases could be done. This is to augment the initial release.

RECOMMENDATIONS

Based on the result of this study, the following are being recommended for better control of TSM:

1. To avoid early field infestation of TSM, use clean (uninfested) planting materials.
2. Monitor TSM infestation 1 – 2 months after planting.
3. Release predatory mites at the early stage of TM infestation.
4. Release rates of 10 – 20 predatory mites is recommended however, this could be increased depending on TSM population.
5. To augment initial release, follow-up releases of predatory mites are recommended.

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