Efficacy of Biomite® and GC-Mite® on *Oligonychus Sacchari* and its predator *Stethorus gilvifrons* on sugarcane; Preliminary results

Abstract

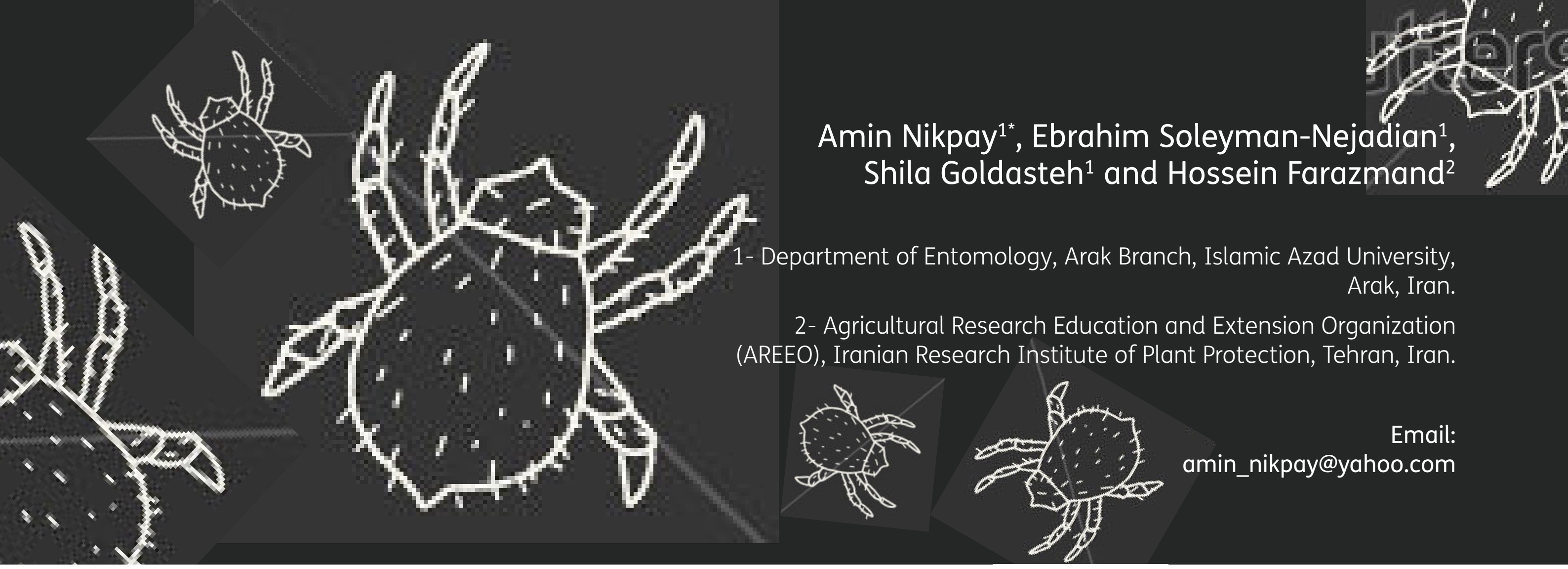
Field trials were conducted at Salman Farsi agro-industry unit in Ahwaz, Iran in 2012 with sugarcane cv. CP48-103 and CP57-614 to elicit the effect of acaricides on the control of sugarcane yellow mite *Oligonychus sacchari* and the impact of these acaricides on predatory beetle *Stethorus gilvifrons*. Acaricides treatments were Biomite® (1, 1.5 or 2 liter/ha) and GC-Mite® (0.3, 0.5 or 1 liter/ha). Each treatment was replicated three times for each commercial variety and control. The control plots were received neither acaricides nor water. The number of mites were recorded after 0 (before spraying), 3, 7, 15 and 30 days after application and predatory beetle were recorded after 10, 20, 30 and 40 days after treatments. The results revealed that there were significant difference between acaricides application and control. All treatments had significant effects after 3 days of application. Biomite® and GC-Mite® at highest dose rate were the most effective treatments after 30 days, but the acaricidal efficacy of both acaricides were reduced and this phenomenon was attributed to high temperature during the tests. There was significant difference between acaricides and control on predatory beetle at 3, 7 days after application. The number of beetles was increased with extended time for all applied dose rates. Sugar content was significantly higher in CP57-614 treated with 2 l/ha Biomite® or 1 l/ha GC-Mite® than the untreated control. .

Keywords: sugarcane yellow mite, *Stethorus gilvifrons*, acaricides, economic injury level

Introduction

Globally about 30 species of spider mites attack sugarcane and most of them are belonging to genus *Oligonychs* Berlese (Beard *et al*., 2003; Bolland *et al*., 1998). Spider mite infestations generally occur during late May-early August in Iran. The lower leaves of sugarcane are usually colonized first. However, prolonged heavy infestations accompanied by extensive damage to the middle and upper leaves of young plants reduce plant growth. While sporadic in nature, infestations invariably impact plant growth and yield. Usually in the summer months, large out-breaks of spider mites can occur in sugarcane fields located in south west Khuzestan province (Nikpay *et al*., 2013) (Figure. 1). Investigators were, of the opinion, that in severe infestation photosynthetic activity was adversely affected and crops appeared red/yellow due to fine webs (Hall *et al*., 2005; Singh *et al*., 2003). All active stages of spider mites damage sugarcane by removing juices from infested leaves, causing premature drying that result in loss of leaf tissue and reduce the plant's ability to produce and store sugar. Possible options for controlling this pest rely on chemical and botanical acaricides (Nikpay *et al*., 2011; Nikpay *et al*., 2012; Singh *et al*., 2003), cultural practices (Hall, 1988; Leslie, 2004; Nikpay *et al*., 2013) and biological control with coccinellids beetles (Biddinger *et al*., 2009). Chemical acaricides have been relied; however, these are not always effective and their continuous use has resulted in resistance among *O. sacchari*

Fig. 1: Damage of sugarcane yellow mite on susceptible variety CP57-614



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populations due to its rapid life cycle and multiple generations.

In India, Singh *et al*., (2003) tested seven acaricides against sugarcane yellow mite O. sacchari under field conditions. The treatments were endosulfan (1.25 lit/ha), monochrotophos (1.25 lit/ha), diclorvas (1.25 lit/ha), quinolphos (1.25 lit/ha), nethrin (1.25 lit/ha), laxmiherbal (25 kg/ha), lime sulphur and control. The researchers found that spraying nethrin and lime sulphur were the most effective treatments in reducing mite damage and increasing sugarcane yield (Singh *et al*., 2003). There are few studies on the control of *O. sacchari* -with acaricides in Iranian sugarcane fields. This study aims to a develop strategy to control sugarcane yellow mite.

One of the most effective biological control agents of *O. sacchari* in Iranian sugarcane fields is *S. gilvifrons*. In some conditions, this species can regulate mite populations. The reasons for this success include regulative potential control of pest populations by long-lived adults, the ability of adults to rapidly immigrate into sugarcane fields and various supporting systems such as floral, nectars, and pollen adjacent plants for *S. gilvifrons* populations before reaching mite populations outbreaks in crops (Afshari, 1999; Biddinger *et al*., 2009). The use of acaricides impacts natural enemies of mite. Therefore, the objectives of the preliminary study were to, 1) assess impact of two acaricides on sugarcane yellow mite populations in different periods, 2) investigate any adverse effects of acaricides on the predatory beetle *S. gilvifrons* (Coleoptera: Coccinellidae) and 3) determine the effects of acaricides on sugarcane quality.

Materials and methods

Acaricides

Two acaricides formulation were used in the field tests:
1) Biomite® (Arysta Lifescience, North America) and
2) GC-Mite® (JH Biotech INC, Canada).

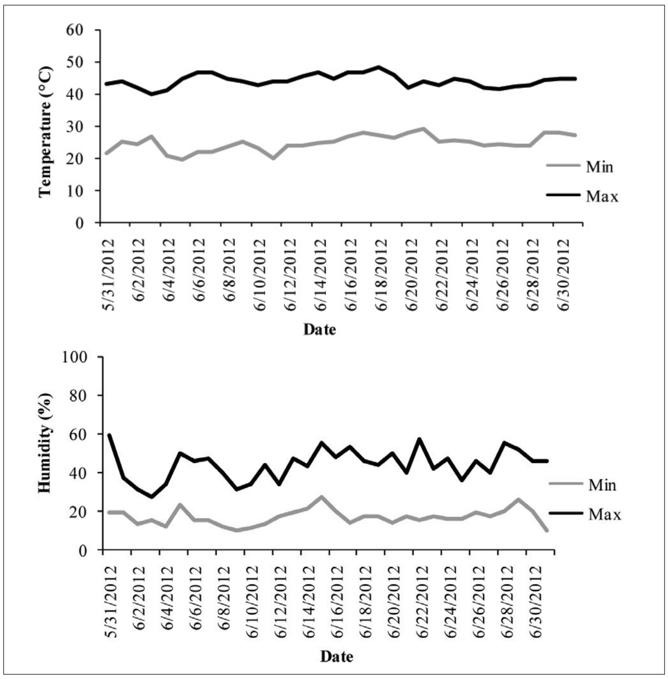
Sugarcane varieties and planting

Two sugarcane varieties CP57-614 and CP48-103 were planted using standard tillage, followed by ridging at 1.8-m furrow spacing. Experimental plots received phosphate (prior to planting) and nitrogen and (during growing season) according to local fertilizer recommendations. Following planting of cane setts (on each furrow); all furrows were treated with herbicides Atrazine and Sencor, as early post-emergence application (2+2 kg per hectare) for efficient weed control.

Experimental design and acaricidal treatments

A randomized complete block design with three blocks was used at Salman Farsi Agro-Industry, Ahwaz-Iran. Each experimental plot (block) consisted of four rows, 6 meter long and 1.8 meter spaced (between two furrows) in different points of field (32.4-m^2 for each plot). This plot configuration is based on recommendation by Laycock, 2004. Each plot was separated by a 1.8-m gap as buffer. The two cultivars were given foliar applications of acaricides Biomite® (at 1, 1.5 or 2 liter/ha) or GC-Mite® (at 0.3, 0.5 or 1 liter/ha) during mite infestations with a 15-liter volume sprayer (Hardi International, England) in late-May 2012. Control plots were not treated. In each plot, fifteen leaves were selected at random from bottom, middle and top of the plant. Samples were kept in plastic bags, returned to laboratory and number of living mites was recorded. Samples were viewed under a stereomicroscope (STZ800 Nikon, Tokyo, Japan) in order to count the mites. Samples were collected at prior test and 3, 7, 15 and 30 days after application of acaricides. In order to assess the side effects of acaricides treatments to the coccinellid beetle *Stethorus gilvifrons* populations, the number of living

Fig. 2: Temperature and humidity (%) during field experiments



beetles (both larvae and adults) was counted following the same procedures for determining mite numbers. Because of beetles activity and relatively rapid flight, all counting were performed in the field. During the experiments, temperature and humidity (maximum and minimum) were obtained from Salman-Farsi meteorological office. For assessing the effects of acaricidal treatments on cane sugar content (including Pol, Brix and Purity), in late September 2012, 15 green whole stalks (in each plot) were selected randomly; trashed stalks were topped by hand at the natural breaking point. Each bundle of 15 stalks was fed through a disintegrator and sub-samples were analyzed for cane sugar content (Pol). Pol is considered as the apparent sucrose content expressed as a mass percent measured by the optical rotation of polarized light passing through a sugar solution. During the field experiments, all data related to temperature and relative humidity were obtained by Salman Farsi meteorological office. Daily temperature and humidity conditions in the period of the experiments are presented in Figure 2.

Data analysis

All data were analyzed for normality and homogeneity of variance (Bartlett's test), and appropriate transformations (Log X and Log X+1) were applied where these conditions were not met, before analysis of variance. All analysis was performed with SPSS software (SPSS version 16, SPSS International, Chicago, USA) and Tukey HSD test was used for comparisons between treatments. Untransformed means and standard errors are shown in the tables and graphs.

Results

The efficacy of Biomite® and GC-Mite® against *O. sacchari* mite on CP57-614 and CP48-103 cultivars is presented in Tables 1-4. Before treatments commenced (time 0), there were not any significant differences amongst the experimental plots. . However, after application, the effect of different concentrations of Biomite® was significantly different at all the time intervals on CP57-614 (Table 1) and CP48-103 (Table 2).

Table 1: Functional description of feeding station elements

	Time interval (days)				
Concentration (liter per hectare)	**0**	**3**	**7**	**15**	**30**
Control	5.37±0.48a	6.22±0.23a	7.02±0.52a	11.55±0.45a	28.35±0.54a
1	4.84±0.47a	0.62±0.09b	1.86±0.11b	7.22±0.25b	17.68±0.30b
1.5	4.42±0.45a	0.35±0.07b	1.17±0.11bc	4.77±0.14c	16.08±0.25c
2	5.06±0.51a	0.04±0.03c	0.73±0.09c	2.88±0.13d	12.53±0.24d

Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$.

Table 2: The efficacy of Biomite® against *O. sacchari* applied on CP48-103

	Time interval (days)				
Concentration (liter per hectare)	**0**	**3**	**7**	**15**	**30**
Control	2.42±0.16a	5.80±0.23a	13.91±0.22a	14.02±0.28a	14.02±0.28a
1	1.24±0.09b	3.06±0.16b	7.22±0.14b	10.11±0.21b	10.11±0.21b
1.5	1.42±0.10bc	3.35±0.16b	7.71±0.15bc	10.13±0.25b	10.13±0.25b
2	1.68±0.10c	3.66±0.19b	8.35±0.19c	10.37±0.19b	10.37±0.19b

Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$.

Table 3: The efficacy of GC-Mite® against *O. sacchari* applied on CP57-614

	Time interval (days)				
Concentration (liter per hectare)	**0**	**3**	**7**	**15**	**30**
Control	5.37±0.48a	7.51±0.47a	12.51±0.32a	18.57±0.29a	28.35±0.54a
1	5.82±0.39a	1.55±0.11b	4.11±0.15b	10.02±0.30b	19.64±0.24b
1.5	5.77±0.45a	1.00±0.11b	3.20±0.12c	9.57±0.20b	18.28±0.17c
2	6.13±0.43a	0.02±0.02c	1.33±0.11d	4.91±0.19c	11.33±0.22d

Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$.

Table 4: The efficacy of GC-Mite® against *O. sacchari* applied on CP48-103

	Time interval (days)				
Concentration (liter per hectare)	**0**	**3**	**7**	**15**	**30**
Control	6.73±0.45a	8.11±0.42a	10.97±0.27a	21.15±0.24a	32.62±0.29a
1	6.22±0.41a	1.60±0.09b	6.73±0.28b	14.77±0.17b	27.40±0.20b
1.5	6.60±0.43a	1.31±0.08b	5.84±0.25c	12.82±0.17c	27.06±0.33b
2	6.64±0.45a	0.0±0.0c	1.77±0.10d	6.44±0.12d	19.53±0.23c

Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$.

The number of mites decreased 3 and 7 days after treatment; however, their number increased after 15 days of exposure to 1 liter per hectare of Biomite® and 30 days exposure to all the concentrations (Table 1). Biomite® was effective for 7 days after treatment of CP48-103. However, the efficacy of Biomite® decreased with increasing time interval to 15 and 30 days (Table 2). There were significant differences among different concentrations of GC-Mite® on CP57-614 (Table 3) and CP48-103 (Table 4).

Results indicated that the population density of predatory beetles decreased following application of Biomite® and GC-Mite®. In all cases significant differences were observed between control group and treatments. There were not any significant differences among different concentrations 3 days after commencement of the experiments. However, with increasing time interval to 7, 15 and 30 days, higher concentrations significantly decreased the population of beetles (Table 5-8).

Concentrations of 2 liter per hectare of Biomite® and 1 liter per hectare of GC-Mite® increased POL of CP57-614. However, in the case of CP48-103 there weren't any significant differences between different treatments and control group (Figure 3).

Discussion

One of the most reliable strategies for controlling mite populations in sugarcane fields is selected spraying of acaricides in "hot spots" when the populations of mite are not high (Nikpay and Soleyman Nejadian, 2014; Singh *et al*., 2003). However, the results of our trials indicated that application of Biomite® and GC-Mite® can reduce the mite populations on the two sugarcane cultivars. In 2003, Singh et al, tested seven acaricidal treatments on cultivar CoS 767, and found that foliar applications of lime-sulphur and nethrin (1.25 Lit/ha) significantly reduced *O. sacchari* infestation and increasing cane yield. In the cultivar CP57-614, there were significant differences in response to Biomite® and GC-Mite®. The same

Table 5: The efficacy of Biomite® against predatory beetles *S. gilvifrons* applied on CP57-614

	Time interval (days)				
Concentration (liter per hectare)	**0**	**3**	**7**	**15**	**30**
Control	1.2±0.12a	1.46±0.11a	2.20±0.10a	3.80±0.02a	6.13±0.12a
1	1.17±0.12a	0.06±0.03b	0.51±0.07c	2.42±0.09b	4.42±0.16b
1.5	1.06±0.11a	0.0±0.0b	0.31±0.06b	1.48±0.08c	3.93±0.12b
2	1.04±0.10a	0.0±0.0b	0.02±0.02b	0.84±0.10d	3.33±0.11c

Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$.

Table 6: The efficacy of Biomite® against predatory beetles *S. gilvifrons* applied on CP48-103

	Time interval (days)				
Concentration (liter per hectare)	**0**	**3**	**7**	**15**	**30**
Control	1.20±0.12a	1.60±0.10a	2.11±0.12a	4.0±0.14a	6.31±0.11a
1	1.17±0.12a	0.06±0.03b	0.66±0.07b	2.17±0.11b	3.84±0.11b
1.5	1.06±0.11a	0.0±0.0b	0.48±0.07b	1.31±0.09c	3.35±0.11c
2	1.04±0.10a	0.0±0.0b	0.0±0.0c	1.06±0.86c	3.08±0.11c

Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$.

Table 7: The efficacy of GC-Mite® against predatory beetles *S. gilvifrons* applied on CP57-614

	Time interval (days)				
Concentration (liter per hectare)	**0**	**3**	**7**	**15**	**30**
Control	1.20±0.12a	1.46±0.11a	2.20±0.10a	3.80±0.12a	6.13±0.12a
1	1.06±0.12a	0.11±0.04b	0.71±0.08b	2.48±0.10b	4.82±0.11b
1.5	1.13±0.13a	0.0±0.0b	0.48±0.07b	2.04±0.11c	4.20±0.14c
2	1.15±0.10a	0.0±0.0b	0.04±0.03c	1.00±0.08d	3.68±0.12d

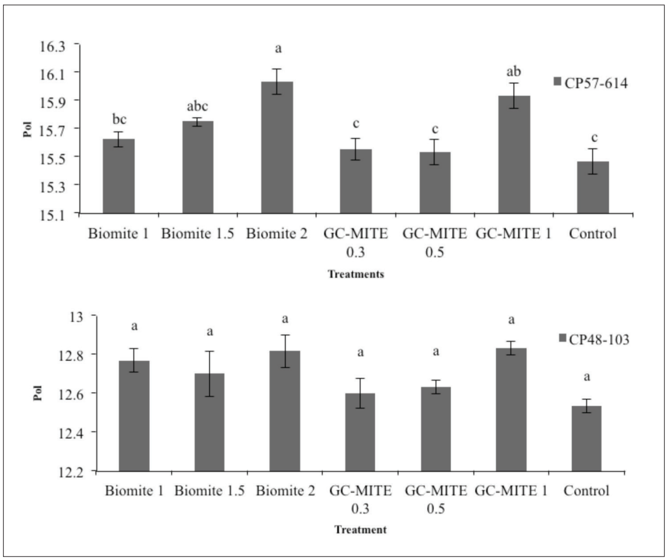
Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$.

Table 8: The efficacy of GC-Mite® against predatory beetles *S. gilvifrons* applied on CP48-103

	Time interval (days)				
Concentration (liter per hectare)	**0**	**3**	**7**	**15**	**30**
Control	1.20±0.12a	1.60±0.10a	2.11±0.12a	4.00±0.14a	6.31±0.11a
1	1.24±0.11a	0.13±0.05b	0.86±0.08b	2.26±0.12b	3.97±0.12b
1.5	1.22±0.13a	0.0±0.0b	0.71±0.08b	1.66±0.10c	3.48±0.08c
2	1.35±0.13a	0.0±0.0b	0.0±0.0c	1.46±0.11c	3.02±0.10d

Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$.

Fig. 3: Pol of the sugarcanes exposed to different concentrations of Biomite and GC-Mite on CP57-614 and CP48-103variety.



Means followed by the same letter at each column are not significantly different using Turkey's Test at $P < 0.05$

results were obtained with cultivar CP48-103. The efficacy of both acaricides was reduced 30 days after application. This is likely to be related to high temperature during crop growth. In a study to control two-spotted mites in apple and tart cherry orchard with acaricides, Alston (2002) found that after 22 days the density of spider mites increased and after 42 days of first treatment, there were no significant difference among treatments. Under field conditions, however, acaricides and other pesticides are known to be affected by weather conditions (Wraight and Ramos, 2002). In past trials with Neem-Azal®, Nikpay *et al.* (2012) found that after 15 days, Neem-Azal® lost its effectiveness against *O. sacchari* - there were no significant differences between Neem-Azal® treatment and control after 15 and 30 days. Biomite® and GC-Mite® have a broad-spectrum action against *O. sacchari* as well as the beneficial coccinellid beetles (*S. gilvifrons*). This was certainly the case in this experirment with both acaricides having an adverse impact on *S. gilvifrons*.

Conclusions

The application of Biomite® and GC-Mite® may protect sugarcane against mites but have some negative effects on coccinellid beetles. Application of acaricides enhanced sugar purity in both cultivars suggesting that high level of mite's infestation can reduce the quality of sugarcane. However, integrating acaricides with other reduced-risk methods such as cultural and biological control could be applied in an IPM program strategy in sugar industry.

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