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Evaluation of soybean aphids against various doses of synthetic insecticides collected from different regions of China

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Abstract

Aphids are a diverse herbivorous group which can infect a variety of plants direct or in direct ways. The effect of soybean aphids may lead to decline plant vigour and growth rates and ultimately reduced the yield. We evaluated effects of Five insecticides on soybean aphids collected from five different regions of China (*Changchun, Jiamusi, Zhalan, suihua and Qiqihar)* at specific doses under controlled conditions during soybean growing session 2018. Insecticides used were *Omethoate, Imidacloprid*, *Spirotetramat Malathion* and *Acetamiprid at recommemded does of* 10, 30, 50, 100 and 150. Our results indicated that, In case of *Jiamusi aphids, Malathion* dose 10 showed relatively greater effect (19.5a) than others. In case of Changchun aphids, *Spirotetramat* dose 10 showed (19.33a) while *Qiqihar aphids* at dose 10 in response to *Spirotetramat* showed (19a). In case of *suihua aphids, Malathion* using 10 multiple gives 17a and *Zhalan aphids against Omethoate at dose 10* showed minimal result of (16.5a). In conclusion, our findings revealed the effectiveness of all listed insecticides against all soybean aphids, however, the toxicity was determined from maximum to minimum in this sequence, *Malathion* > *Spirotetramat* > *Omethoate.*

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Introduction

Soybean aphid also known as *Aphis glycines* is the most invasive pest found in Asia (Ragsdale *et al.,* 2011). Soybean aphids act on phloem sap and ultimately affect soybean seed size and yield (Beckendorf *et al.,* 2008). It is the basic primary insect which is recently managed by soybean growers in North America (Hurley and Mitchell, 2017). However, aphid populations can still occasionally build to economically damaging levels on various plants, which ask for treatment with immediate insecticides to safeguard the worldwide yields. *A. glycines* are tiny, holding light yellowish green morphology along with 2 black cornicles. Their combination of morphological characteristics as well as its pattern of colonization upon soybean, distinguishes it from various other types of aphid species. (Voegtlin *et al.,* 2004).

The major symptoms of soybean aphid infested plants exhibits a variety of morphological, chemical, biochemical, and environmental changes such as stunted growth, plant senescence, distorted and wrinkled foliage, irregular roots, stems and leaves reduced branch size and minimal seed count (He *et al.,* 1995; Lin *et al.,* 1992, 1994; Wang *et al.,* 1962, 1996; Wu *et al.,* 1999). In China, Among many soybean insect pests, Aphis glycines Matsumura (Hemiptera: Aphididae) is attributed as severe threat to overall production of soybean (Sun *et al.,* 2000; Wang *et al.,* 1962, 1996; Wu *et al.,* 1999; Yue *et al.,* 1989). During 1998, a 30% of heavy loss in the total yield along with 112.5 million kilograms reduction was caused due to soybean aphid infestation at Suihua and Heilongjiang regions of china (Sun *et al.,* 2000). Moreover, In Japan, Indonesia, Russia, The Philippines, Australia and recently Canada and United states have been reporting severe invasion of soybean aphids (APPPC, 1987; CAB International, 2001; Fletcher and Desborough, 2002; USDA, 2002; Venette, 2004).

Numerous tactics have been applied to tackle the control of soybean aphids worldwide in order to minimize the effect and population densities of soybean aphids as per suggestion of integrated pest management (IPM) programs. . However, foliar insecticides specifically pyrethroids and organophosphates, proved to be the basic and primary way for the suppression (Hodgson *et al.,* 2012). Multiple insecticides against soybean aphid have been studied such as omethoate, deltamethrin, cyhalothrin, phosalone, fenvalerate, Phorate, imidacloprid (Chen and Yu, 1988; Heinrichs *et al.,* 1984; Qu *et al.,* 1987; Ragsdale *et al.,* 2007; Tabadkani *et al.,* 2017). The purpose of our study was to find the efficiency, activity and chemical control of various groups and doses of insecticides applied on soybean aphids taken from five different parts of china.

Materials and methods

Experimental location and layout

Experiment was conducted at College of Agronomy, Jilin Agricultural University, *Changchun, China.* Soybean variety (agriculture entomology 38) was grown in pots with controlled temperature 26±1°C in green house. Water was given to the plants two times a day along with sulphur and potassium fertilizers. Aphids sample were collected from native soybean crops of five different areas of china including (*Changchun, Jiamusi, Zhalan, suihua and Qiqihar).* These were multiplied on the soybeans in controlled environment with 26±1°C, 60±5% relative humidity [RH] and a photoperiod of 16:8h, after two generations fresh colonies were obtained and subjected to chemicals. Insecticides were bought from Guangzhou, China.

Chemical control

In case of Changchun aphids we prepared five selected insecticides (*Omethoate, Imidacloprid, Spirotetramat Malathion* and *Acetamiprid)* with five different doses (10, 30, 50, 100 and 150). Treatments of Changchun aphid with aforementioned groups of insecticides were carried out in a 0.5 ml solution when the number of soybean aphids reached to its optimum growth followed by 30-40 minutes of drying. Each group of insecticide with multiple doses were applied one by one with the help of 1 foot long glass tubes. Each reaction included 20 aphids per tube. The reaction was performed in triplicates. Data was recorded 5-6 hours post treatment of insecticides and compared with control group (0) of each insecticide. Similar methodology was followed for *Jiamusi* aphids, *Zhalan* aphids*, suihua* aphids *and Qiqihar* aphids. The comparative data analyses for each group against selected insecticides were calculated according to complete Randomized design (CRD) by Statistix 8.1 softwere.

Aphids multiplication

Five different groups of soybean aphids were sampled from different regions of China. (See methods for details). These five selected groups were further multiplied by feeding soybean variety (agriculture entomology 38) until third generation was obtained. The results indicated that these aphids were actively invading our soybean variety hence confirming that feeding soybean variety (agriculture entomology 38) was not naturally resistant to these groups of aphids.

Preparation of multiple doses of insecticides

Multiple doses (5) for each group of insecticides were prepared in the following concentrations.

Water solution = 1000ml water+ CH3COOH3 1000µl+TritonX-100 (1000µl)

Insecticidal solution = water solution 100ml+1000µl insecticide

Dose 10 = 10ml of water solution+1000µl of insecticide solution

Dose 30 = 30ml water solution + 1000µl insecticide solution

Dose 50 = 50ml water solution + 1000µl insecticide solution

Dose 100 = 10ml water solution + 100µl insecticide solution

Dose 150 = 15ml water solution +100µl insecticide solution

Results

Response of Changchun aphids

The chemical control of Changchun aphids on five groups of insecticides was analyzed after the extensive treatment. The results revealed that *Spirotetramat* shows relatively higher effect (19.33a) at dose 10 compare to other groups.

Table 1. The effect of *Changchun* aphids against five different groups of insecticides.

Insecticide name	Dose 0	Dose 10	Dose 30	Dose 50	Dose 100	Dose 150	LSD	CV%
Omethoate	2.0e	17.6 a	15.3 b	14.3 b	12.3 c	9.6d	2.2	6.58
Imidacloprid	2.0d	18.3a	19.0a	17.6ab	16.0bc	15.6c	2.2	6.7
Spirotetramat	2.0c	19.33a	17.33a	16.6ab	14.3b	2.3c	2.2	13.0
Malathion	2.0d	16.5a	12.5ab	13ab	10bc	5.5cd	2.4	25.87
Acetamiprid	2.0e	11.6a	8.6b	8.3b	6.6c	4.3d	2.2	11.26

In case of *Imidacloprid* exhibits nearly similar effect (19a) with previous one however the dose dependency was found different 30. Furthermore, *Omethoate response against Changchun aphids was recorded* (17.6a) when the dose was kept 10. Lastly the results of *Malathion on dose* 10 were recorded maximum (16.5a) and *Acetamiprid on dose10 showed* (11.6a) response (Table 1). All of the given groups of insecticides and their multiple doses were found non significantly variable from each other at 5% probability in comparison to control.

Response of Jiamusi aphids

The chemical control experiment in case of *Jiamsui* aphids on five various groups of insecticides was recorded after treatment. Here *Malathion* showed maximum effect (19.5a) at dose 10 comparatively. The second group that exhibits maximum response was found *Omethoate* (17.5a) when encountered on dose 10. Afterwards, *Spirotetramat response against Changchun aphids was recorded* (17a) at dose 10. The data of *Imidacloprid* and *Acetamiprid on dose* 10 exhibits (15.5a) and (10.6a) respectively (Table 2).

Table 2. The effect of *Jiamsui* aphids against five different groups of insecticides.

Insecticide name	Dose 0	Dose 10	Dose 30	Dose 50	Dose 100	Dose 150	LSD	CV%
Omethoate	1.5d	17.5a	15ab	11.5b	6.5c	4cd	2.4	16.37
Imidacloprid	1.5d	15.5a	14ab	12.5bc	12.5bc	10.5c	2.4	9.39
Spirotetramat	1.5d	17a	15ab	13bc	15ab	11.5c	2.4	8.88
Malathion	1.5d	19.5a	16.5ab	15b	9c	5.5cd	2.4	16.3
Acetamiprid	1.6e	10.6a	9.3b	6.3c	5.3c	3.3d	2.2	11.57

All of the given groups of insecticides and their multiple doses were found non significantly variable from each other at 5% probability in comparison to control.

Response of Zhalantun aphids

Experimental control of *Zhalantun* aphids upon five different types of insecticides were tested post-treatment under controlled environment.

Data showed that *Omethoate* gives best response (16.5a) at dose 10 in comparison to others.

Table 3. The effect of *Zhalantun* aphids against five different groups of insecticides.

Insecticide name	Dose 0	Dose 10	Dose 30	Dose 50	Dose 100	Dose 150	LSD	CV%
Omethoate	2.0e	16.5a	13b	12bc	9.0d	9.5cd	2.4	11.85
Imidacloprid	2.0c	12a	7.5b	8.5ab	7b	5bc	2.4	25.4
Spirotetramat	2.0e	15.5a	13ab	12bc	9cd	8d	2.4	13.3
Malathion	2.0e	11.5a	9.5b	8.5b	5.5c	4c	2.4	8.45
Acetamiprid	2.0a	1.5ab	1b	0c	0c	0c	2.4	38.5

The second group that exhibits maximum response was found *Spirotetramat* (15.5a) at the same dose as first one. Then, *Imidacloprid* response was recorded (12a) 10 dose. The results of *Malathion* and *Acetamiprid on dose* 10 exhibits (11.5a) and (1.5a) respectively (Table 3). All of the given groups of insecticides and their multiple doses were found none significantly variable from each other at 5% probability in comparison to control.

Response of Suihua aphids

Suihua aphids and their chemical control with five multiple types of insecticides were analyzed according to the previous method under controlled conditions.

The variable datasets were recorded with maximum response in case of *Malathion* (17a) at dose 10 in comparison to others. After *Malathion*, another group of insecticide named *Spirotetramat* exhibits (15a) at the same dose of 10. Furthermore, *Imidacloprid* and *Omethoate* showed a similar pattern of response of (14a) when the dose was kept as 10.

Table 4. The effect of Suihua aphids against five different groups of insecticides.

Insecticide name	Dose 0	Dose 10	Dose 30	Dose 50	Dose 100	Dose 150	LSD	CV%
Omethoate	1.5d	14a	10b	9bc	8bc	6c	2.4	16.4
Imidacloprid	1.5e	14a	13ab	11.5bc	10.5c	8.5d	2.4	8.3
Spirotetramat	1.5c	15a	12ab	6.5bc	5bc	2.5c	2.4	43.7
Malathion	1.5e	17a	15.5ab	13.5bc	11.5c	8d	2.4	10.3
Acetamiprid	1.5ab	6a	2.5ab	2.5ab	2ab	0b	2.4	88.6

The data of *Acetamiprid at dose* 10 exhibits (6a) which was found the least recorded statistics in *Suihua* aphids (Table 4). All of the given groups of insecticides and their multiple doses were found non significantly variable from each other at 5% probability in comparison to control.

Response of Qiqihaer aphids

The effect of Qiqihaer aphids was tested with five multiple types of insecticides were analyzed. Data was recorded for *Spirotetramat* to be the best among all selected insecticides which was (19a) at 10 dose followed by *Malathion* and *Imidacloprid* exhibiting

(14a) when the dose was kept as 10. Minimum response of qiqihaer aphids were recorded for *Omethoate* and *Acetamiprid* giving (10.5a) and (8a). Both of these insecticides showed this response on dose 10 respectively. All of the given groups of insecticides and their multiple doses were found non significantly variable from each other at 5% probability in comparison to control (Table 5).

Table 5. The effect of *Qiqihaer* aphids against five different groups of insecticides.

Insecticide name	Dose 0	Dose 10	Dose 30	Dose 50	Dose 100	Dose 150	LSD	CV%
Omethoate	2.5cd	10.5a	7b	5bc	3.5cd	1d	2.4	28.16
Imidacloprid	2.5d	14a	10b	8.5bc	6cd	5cd	2.4	20.6
Spirotetramat	2.3f	19a	17.3b	12.3d	13.6c	10.7e	2.2	4.2
Malathion	2.5e	14a	12.5a	9.5b	6.5c	4.5d	2.4	7.8
Acetamiprid	2.5b	8a	4ab	3b	2b	1.5b	2.4	48.1

Discussion

Soybean aphid is a serious insect of soybean crop. Before the outbreaks of soybean aphids a few amount of insecticides were used but these days insecticides are very common tool to control populations of soybean aphids and it was used as primary tool for soybean aphids control in United states in first decade. There are many kinds of insecticides available in market (Fernandez Cornejo and Jans 1999), (DiFonzo 2009, Hodgson *et al*., 2010), (Beckendorf *et al.,* 2008).

(Faheeem *et al*., 2016) applied Malathion on S. graminum and observed that Malathion is highly effective against S. graminum, while in case of our study Malathion dose 10 shows 19.5a to Jiamusi aphids, 17a to suihua aphids, 16.5a to Changchun aphids, 14a to Qiqihaer aphids and 11.5a to Zhalantun aphids.

Table 6. Maximum damage shown by specific dose of insecticides against specific soybean aphids.

Insecticide with Dose	Aphids	Damage
1. *Malathion* dose 10	Jiamusi aphids	19.5a
2.Spirotetramat dose 10	Changchun aphids	19.33a
3. Spirotetramat dose 10	Qiqihqar aphids	19a
4. Malathion dose 10	Suihua aphids	17a
5. *Omethoate* dose 10	Zhalan aphids	16.5a

(Magalhaes *et al*., 2008) observed a high temporal variation in field efficacy for imidacloprid against soybean aphid and they proved that imidacloprid showed good lethal and sublethal results against soybean aphid reproduction and survival. (Shafique *et al*., 2016) and (Royer *et al*., 2011) used Imidacloprid to control S. graminum and results proved that Imidacloprid gave maximum decrease in populations of S. graminum and (Faheem *et al*., 2016) showed that imidacloprid showed only 41% reduction in S. gramium and in our study Imidacloprid showed 18.3a in Changchun aphids, 15.5a in Jiamsui aphids, 14a in Qiqihar aphids and Suihua aphids and 12a in Zhalantun aphids.

(Y. Gong *et al*., 2016) applied spirotetramat to cotton aphids for five days and revealed that it gives a slow effect on killing cotton aphids , their results showed that its lethal and sublethal doses decreases the fecundity of cotton aphids, LC75 dose of spirotetramat decreased 90% of cotton aphid offspring. While in our study spirotetramat 19.33a in Changchun aphids , 19a in Qiqihaer aphids , 17a in Jiamsui aphids , 15.5a in Zhalantun aphids and 15a in

Suihua aphids.

Previous studies indicate that acetamiprid causes reduction of populations against pomegranate aphid, A. punicae and its activity is not disturbed with passage of time like imidacloprid activity is decreased with time , it is also effective against C. carnea and S. corolla (A. Abd-Ella *et al.*, 2015). While our study shows acetamiprid shows higher effect 11.6a in Changchun aphids while minimum effect 1.5a in zhalantun aphids.

(Bishop *et al.*, 1998) revealed that Omethoate influences the population, structure and new emerging generation of lucerne flea , omethoate has effective ,immediate and long lasting effect on populations of lucerne flea.our studies reveals omethoate activity against changchun aphids is 17.6a while jiamsui aphids 17.5a, 16.5a in Zhalantun aphids, Suihua aphids 14a and 10.5a in Qiqihaer aphids.

Our experiment reveals that different insecticides shows different effects in different kinds of aphids while the activity of insecticides seen is Malathion followed by Spirotetramat followed by Omethoate.

Conclusion

We concluded that Jiamusi aphids were more killed by Malathion dose 10 as compared to others while against Changchun aphids and Qiqihqar aphids, Spirotetramat dose 10 performed better than others. Meanwhile, Suihua aphids died more by Malathion dose 10 and in case of Zhalan aphids, Omethoate at dose 10 gave better results than others. So, we recommend Malathion dose 10 for Jiamusi aphids and Suihua aphids, Spirotetramat dose 10 for Changchun aphids and Qiqihqar aphids and Omethoate dose 10 for Zhalan aphids (Table 6).

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Conflict of interest

The authors declare that they have no conflict of interest.

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