J. Appl. Res Plant Sci. Vol. 4(1), 477-484, 2023, https://doi.org/10.38211/joarps.2023.04.01.57

OPEN ACCESS

Research Article

Available on https://www.joarps.org
Journal of Applied Research in Plant Sciences
(JOARPS)
ISSN: 2708-3004 (Online), 2708-2997 (Print)

Biophysical Management of Aphid (*Schizaphis graminum* Rondani) (Hemiptera: Aphididae) in Wheat Crop

Muhammad Waqas ul Hassan[1,4], Muhammad Nadeem[2,3]*, Hafeez Ur Rehman[1], Jamshaid Iqbal[1], Muhammad Shakeel Hanif [3], Amer Rasool[4], Imtiaz Akram Khan Niazi[3], Muhammad Aslam[3], Abdul Ghaffar[2], Sikandar Hayat[3], Aftab Ahmad Khan[3], Ehsan Ul Haque[5]

[1]Faculty of Agriculture, Gomal University, Dera Ismail Khan, KPK, Pakistan.
[2]Arid Zone Research Institute, Bhakkar, Punjab, Pakistan.
[3]Fodder Research Institute, Sargodha, Punjab, Pakistan.
[4]Pest Warning and Quality Control of Pesticides, Punjab, Lahore.
[5]Citrus Research Institute, Sargodha, Punjab, Pakistan.
*For Correspondence: E-mail: nadeemazri@gmail.com

Article Received 20-08-2022, Article Revised 11-10-2022, Article Accepted 11-11-2022

Abstract

Aphid is a major pest of wheat that causes substantial agricultural damages to wheat crop annually. In the present study, experiments on ecofriendly management of this pest were conducted at the experimental area of Arid Zone Research Institute (AZRI), Bhakkar. The trials were laid down in Randomized Complete Block Design (RCBD) with three replications. Data was collected at seven days interval by counting method. As far as efficiency of yellow sticky traps is concerned, the plot having 4-traps captured maximum (848.07) aphids. As a result, minimum (11.16 aphid tiller^{-1}) were observed in the respective plot. The same plot exhibited maximum population reduction (71.93%) and grain yield (6617.9 kg ha^{-1}). The plot having 1-trap captured minimum (257.33) aphids. Consequently, maximum (33.37 aphids/tiller) were found in the field. The same treatment showed minimum population reduction (23.99%) and grain yield (5489.1 kg ha^{-1}). *Chrysoperla carnea* was found a voracious predator of the pest. The plot having 4-egg cards of this predator showed minimum (7.69 aphids tiller^{-1}) with maximum (49.50%) population reduction of the aphid followed by 8.78 aphids/tiller in the plot having 3-egg cards with 42.56% population reduction. Lowest population reduction (12.33%) was found in the plot having 1 egg card.

Keywords: Schizaphis graminum, Chrysoperla carnea management, resistance, sticky trap,

Introduction

Wheat *Triticum aestivum* L. (Gramineae) is one of the major rabi crop, covering the largest area in the world (Anwar *et al.*, 2009). It provides basic dietary requirements in a sufficient and well balanced form to human race (Kausar *et al.*, 2013; Khakwani *et al.*, 2012). In Pakistan wheat is cultivated over 22 million acres and accounts for 7.8 % of the value added in agriculture and 1.8 % of GDP. In 2021-22, the area under wheat cultivation decreased to 8,976 thousand hectares (2.1 %) as compared to previous year 9,168 thousand hectares because of that the production of wheat declined to 26.394 million tonnes (3.9 %) compared to 27.464 million tonnes in the last year (Anonymous, 2021-22).

Wheat production plays an important role in the economy of Pakistan. However, the yield per hectare is low as compared to other countries in the world. Myriad of studies have reported that several factors are responsible for low yield including heat, drought, traditional methods of cultivation, poor soil fertility, lack of irrigation facilities, weeds, low producing cultivars, lack of resistant varieties, higher incidence of diseases and insect pests (Khan *et al.*, 2012; Memon *et al.*, 2013).

Many insect pests, such as cereal leaf beetle, wheat stem sawfly, pink stem borer, Hessian fly, armyworm and aphid feed on this wheat crop (Kamran *et al.*, 2013; Shanower *et al.*, 2004) among which the aphid is considered as one of the major pest of this crop (Steffey *et al.*, 2012).Wheat aphid (*Schizaphis graminum* R.), commonly known as plant lice is distributed throughout the world and feeds on about sixty host plants including wheat, sorghum, barley, corn etc (Bosque-Pérez *et al.*, 2000). It has been reported as the major pest of wheat crop in Pakistan (Kamran *et al.*, 2013)

In temperate regions w aphid reproduces asexually throughout the year. Due to occasional sexual reproductions, it has developed different biotypes. So far, eleven biotypes have been identified taxonomically (A to K) showing different behavior to resistant cultivars and pesticides (S Kindler *et al.*, 2002). Its huge population transfers onto sorghum after harvesting of wheat and colonize in masses while in the absence of sorghum crop, the pest shifts to non cultivated grasses (Anstead *et al.*, 2003)

S. graminum (R.) settles on wheat for a short time span, and multiplies rapidly (Jarošík *et al.*, 2003). It passively feeds on cell sap by injecting the stylet into sieve tubes and stylet penetration is facilitated by secretion of saliva containing protein (Miles, 1999). Aphid causes indirect damage by transmitting numerous plant viruses and fungi (Aslam *et al.*, 2005) By secreting honey dew, on which sooty mold fungus grows (Akhtar *et al.*, 2003). The pest causes 35-40% losses by desaping and 20-80% by disease transmission (Kuroli, 2000) and is considered the most significant factor of declined yield (SD Kindler *et al.*, 2001).

Various methods viz. host plant resistance, physical, cultural, mechanical, biological, and chemical have been evolved to control this pest. Applications of insecticides have adverse effect on the population of natural enemies, favour the development of insecticide resistance and deteriorate quality environment (Jansen, 2000). It has become necessary to adopt integrated pest management strategy to reduce the chances of biotypes development and minimize the hazardous of pesticides on environment (Burd *et al.*, 2009)

A growing number of studies have reported that sticky traps play an important role in aphid management. Insects are attracted to variety of colours so knowledge about colour preference of insects makes it easier to design traps by using attractive colours. Yellow colour is commonly used to attract the insects throughout the world. Entomologists use this technique to collect Homopterans, Coleopterans, Hymenopterans and Thysanopterans ((Kersting *et al.*, 1995)). Traps of different colours are usually used to monitor the population of pest and beneficial insects throughout the world. Based on insect response to different colours, pest management programmes have been developed by using traps. (Gu *et al.*, 2008).

Biological control is an efficient and rational component of pest management. Many species of *chrysopidae* family are important predators of various aphid species and many other arthropods (Senior *et al.*, 2001). *Chrysoperla carnea* also known as aphid lions is an important naturally occurring predator in many agricultural crops. Due to its wide-ranging habitats, it is commercially available in all the corners of world (Tauber *et al.*, 2000). It feeds on many species of aphids including *S. graminum* (Pappas *et al.*, 2007). Under favourable conditions, it can reduce aphid population up to 90% (Messina *et al.*, 2001).

Release of green lacewings can efficiently be integrated with other control tactics, such as use of Bt plants and selective insecticides. Many scientists suggest that chrysopids have broad level of tolerance to commonly used pesticides (Mandour, 2009).

To meet the basic dietary requirements of increasing population, it is crucial to increase the yield of wheat by managing insect pests. Keeping in view the importance of wheat crop and economical losses caused by aphid, the present study was designed with the following objectives.

To determine efficiency of yellow sticky traps for the management of wheat aphid and To evaluate the role of *C. carnea* (Stephens) in aphid management under field conditions.

Materials and Methods

Aphid is a major pest of wheat crop in Pakistan. Experiments were carried out at the experimental area of Arid Zone Research Institute, Bhakkar Punjab, Pakistanfor ecologically sound management of this pest.

Efficiency of Yellow Sticky Traps for the Management of Wheat Aphid: An experiment was carried out to determine the efficiency of yellow sticky traps against wheat aphid. The trial was laid down in Randomized Complete Block Design (RCBD) with five treatments including control (T1 = 4 Traps, T2 = 3 Traps, T3 = 2 Traps, T4 = 1 Traps and T5 = Control). Each treatment was replicated three times. Wheat variety, Gold-2016 was sown on November 12, 2016 in straight lines by standard sowing method (hand drill) with row to row distance of 30 cm. Plot size of 20 × 20m was maintained for each treatment. Normal cultural practices were performed uniformly in all the treatments. The plots were kept unsprayed throughout the experiment (Muhammad *et al.*, 2013).

Aphid population was recorded just before installation of the yellow sticky traps and then at weekly intervals after installation of the traps. Yellow sticky traps measuring 20 × 25cm were installed during third week of February at 5 cm above the crop height. Data on aphid population were recorded by visual counting on both sides of the traps. For this purpose, fifteen tillers were selected randomly in each treatment and aphids were counted by in-situ technique from each tiller . The traps were replaced at weekly interval after recording data.

Percent population reduction in aphid population was calculated by using the following formula.

$$\text{Percent Population Reduction} = \frac{\text{Population in Control} - \text{Population in Treatment}}{\text{Population in Control}} \times 100$$

Randomly selected one meter square area from three different spots in each treatment was harvested and tied into bundles having labeled tags. The bundles were brought to entomological laboratory and threshed manually. The grains were weighted on electronic balance. The yield so obtained was converted into yield/hectare using the following formula (Shahzad *et al.*, 2013)

$$Grain\ Yield\ per\ ha = \frac{\text{Grain Yield}}{\text{Area Harvested}} \text{X10000}$$

Data were subjected to analysis of variance (ANOVA). LSD test was applied at 5% level of significance to compare the means using Statistics 8.1(Junaid *et al.*, 2016).

Detail of Treatments

T_1= 4 traps/400 m^2 T_2=3 traps/400 m^2 T_3= 2 traps/400 m^2
T_4=1 traps/400 m^2 T_5=Control

Role of *Chrysoperla carnea* (Stephens) in Aphid Management under Field Conditions: To determine the role of *C. carnea* (S.) in aphid management. The experiment was laid down in Randomized Complete Block Design. The trial was consisted of five treatments (T_1=4cards, T_2=3 cards, T_3=2 cards, T_4=1 card and T_5=Control) and each treatment was replicated thrice . The Ujala-2016 wheat variety was sown in straight lines by standard sowing method (hand drill) with row to row distance of 30 cm. An area of 4 × 1.25m was maintained for each treatment. Normal cultural practices were performed uniformly in all the treatments. The plots were kept unsprayed throughout the experiment *C. carnea* egg cards, each containing 100 eggs were slanged at 3cm below the top of wheat tiller during 4th week of February(Iqbal *et al.*, 2008).

Data on the aphid population were recorded 24 hours before and 7, 14, 21, 28 days after installing the egg cards. Fifteen tillers per plot were randomly selected and the aphid population was recorded on each tiller at weekly intervals (Aheer *et al.*, 2017).

Percent population reduction in aphid population was calculated by using the following formula.

$$\text{Percent Population Reduction} = \frac{\text{Population in Control} - \text{Population in Treatment}}{\text{Population in Control}} \times 100$$

Data were subjected to analysis of variance (ANOVA). LSD test was applied at 5% level of significance to compare the means by using STATISTIX 8.1

Detail of Treatments

T_1= 4 cards/5 m^2 T_2=3 cards/5 m^2 T_3= 2 cards/5 m^2
T_4=1 card/5 m^2 T_5=Control

Results and Discussions

Efficiency of Yellow Sticky Traps for Management of Wheat Aphid

Aphid Population Captured on Traps: Aphid population captured on yellow sticky traps at different intervals is shown in Table 1. Data recorded on 2nd March, showed that maximum aphid population (1286.0) was captured in the plot, where 4-Traps were installed, followed by 949.0 aphids in the plot having 3-traps. Significantly lowest (370.3) aphid population was observed in the plot where only 1-Trap was installed, followed by 675.3 aphids in the plot where 2-Traps were installed.

Data recorded on 9th March, showed that maximum population of aphid (1410.3) was captured from the plot having 4-Traps, followed by 1155.7 aphids in the plot, where 3-Traps were installed. Significantly lowest population of the pest (446.3) was noted in the plot where 1-Trap was installed.

Data recorded on 16th March, showed that maximum (854.3 aphids) were captured from the plot having 4-Traps. While, minimum population of the pest (251.67 aphids) was captured from the plot having 1-Trap. Similar trend was observed in the data recorded on 23rd March. Maximum 510.0 aphids were captured on 4-Trap's plot while minimum population (163.33) was recorded from the plot having 1-Trap.

Data recorded on 30th March showed that maximum population of aphid (179.33) was observed at the plot where 4-Traps were installed, which was statistically similar with 152.0 aphids in the plot where 3-Traps were installed. Similarly 98.0 and 55.0 aphids captured from the plot having 2 and 1-Trap respectively were also statistically similar with each other.

Overall mean of captured population in traps showed that the plots having more traps captured more aphids, while the plots with less traps, captured lowest number of aphids. It is clear from the results that 848.67 aphids were captured in the plot having 4-Traps, followed by 677.87 aphids in the plot where 3-Traps were installed. Similarly least number of aphids

(257.33) was captured from the plot where only 1-trap was installed.

Aphid Population in Field: Field data recorded from the plot having traps showed that all the treatment provided significant results compared to control (Table 2). The plot with the most traps was installed captured maximum population of aphid. As a result, minimum aphid population was found in the field. Similarly the field having less traps, captured minimum number of aphids and subsequently maximum aphid population was found in the field. Data recorded on 2nd March, showed significantly highest population of aphid (60.22 aphids /tiller) from the control plot. Maximum (37.84 aphids /tiller) was recorded from the field, where 1-trap was installed. Significantly lowest population of aphid (14.0 aphids /tiller) was found in the plot having 4-traps.

Data recorded on 9th March, showed maximum (64.80 aphids /tiller) from the plot having 1-trap, which was significantly different from control plot showing 86.11 aphids /tiller. Minimum 19.62 aphids /tiller were found in the field having 4-traps, followed by 33.89 aphids /tiller in the plot having 3-traps.

Data recorded on 16th March, showed maximum aphid population (38.13 aphids /tiller) from the field having 1-trap, which was significantly different from control plot showing 45.91 aphids /tiller. Significantly lowest aphid population (14.91 aphids /tiller) was found in the plot having 4-traps followed by 24.69 aphids /tiller in the plot having 3-traps.

Data recorded on 23rd March showed significantly highest population of the pest (32.22 aphids /tiller) from the control plot, Whereas among treatments, maximum population (25.26 aphids /tiller) was found in the field having 1-trap, followed by 16.53 aphids /tiller having 2-Traps. Significantly lowest population of the pest (6.84 aphids /tiller) was found in the plot having 4-traps, followed by 12.93 aphids/tiller having 3-traps.

Data recorded on 30th March, showed maximum (1.0 aphid/tiller) from control plot, while among treatments maximum population (0.80 aphid/tiller) from the field where 1-trap was installed. Significantly lowest (0.4) aphid/tiller was found in the plot having 4-Traps.

Overall mean of the data showed maximum population of the pest (45.09 aphids /tiller) from control plot, followed by 33.37 aphids /tiller from plot having 1 trap. Significantly lowest population of the pest (11.16 aphids /tiller) was found in the plot having 4-traps, followed by 19.64 aphids/tiller having 3-traps.

Percent Population Reduction: Data regarding percent reduction in aphid population due to installation of traps showed that all the treatments having different number of traps showed significant population reduction over control (Table 3). Maximum population reduction (71.93%) was observed in the plot having 4-traps. The plot having 3-traps showed 52.93% population reduction, which was significantly different from the plot having 4-traps. Similarly least population reduction (23.99%) was found in the plot having 1-trap, followed by 39.25% in the plot having 2-traps.

Grain Yield: Data presented in Table 4 showed the grain yield of different treatments. It was observed that significantly lowest yield (5160.6 kg ha^{-1}) was recorded from the control plot, followed by 5489.1 kg ha^{-1} in the plot having 1-trap. Maximum grain yield (6617.9 kg ha^{-1}) was achieved from the plot having 4-traps, followed by 6338.8 kg ha^{-1} in the plot with 3-traps.

Our findings are quietly in line to that of (Cho *et al.*, 1995; El-Wakeil *et al.*, 2013; Hassan *et al.*, 2004; Lu *et al.*, 2012) studied efficiency of yellow sticky traps and recorded that aphids, whitefly, leafminer fly, thrips, parasitic wasp and shore fly were attracted and trapped on these traps. They reported that significantly highest number of thrips trapped on yellow color traps compared to others. (Hassan *et al.*, 2004) evaluated the trapping efficacy of seven coloured sticky traps including yellow against insects of cucumber crop under green house conditions. They reported that thrips, aphids and leafminer were attracted significantly higher to the fluorescent yellow traps. (Lu *et al.*, 2012) reported that yellow sticky traps can effectively be used to manage sucking insect pests under greenhouse conditions. (El-Wakeil *et al.*, 2013) resulted that cereal aphid were highly attracted to yellow colour traps in wheat crop.

The current results showed that the plot having 4-traps captured maximum aphid population (848.67). As a result, minimum population (11.16 aphids /tiller) was found in the respective field. This treatment showed maximum population reduction (71.93%) and grain yield (6617.9 kg ha^{-1}). The plot having 1-trap captured minimum (257.33) aphids. Consequently, maximum population (33.37 aphids /tiller) was found in the field. The treatment provided minimum population reduction (23.99%) and grain yield (5489.1 kg ha^{-1}).

The present findings are installation of 4 yellow sticky traps provided maximum population reduction by capturing maximum aphids and produced maximum yield among rest of the treatments.

Role of *Chrysoperla carnea* (Stephens) in Aphid Management under Field Conditions: Aphid population affected by the release of *Chrysoperla carnea* is presented in Table 5. It is obvious from the results that before installation of *Chrysoperla* egg cards in the field, aphid population was non-significantly different from each other in all the treatments. However, after 7th day of installation of egg cards, it was found that significantly highest population (35.31 aphids per tiller) was found in control plot, followed by 31.64 in the treatment having 1-Card. Lowest population of (20.98 aphids per tiller) was found in the plot having 4-Cards which was statistically similar with 22.47 aphids per tiller in the plot having 3- eggs cards.

Similarly data recorded on 14th day after the release of egg cards, it was observed that all the treatments significantly reduced pest population compared to control. Maximum pest population (21.91 aphids per tiller) was recorded with the release of 1 egg card per plot. Minimum (10.87 aphids per tiller) was found in the plot having 4-cards followed by 14.07 in the plot having 3 cards per plot. Maximum aphid population (24.82 aphids per tiller) was observed from control plot.

Data recorded on 21th day after the release of egg cards showed lowest aphid population (2.49 aphids per tiller) in the plot having 4 cards, which was statistically similar with 2.98 aphids per tiller in the plot having 3 egg cards. Maximum population (10.40 aphids per tiller) was recorded in control plot, followed by 8.42 in the plot having 1 card.

Data recorded on 28th days after release showed that maximum aphid population (1.38 aphids per tiller) was found in control plot, followed by 1.22 in the treatment having 1 card. Lowest population (0.5 aphid /tiller) was found in the plot having 4 cards which was statistically different with 0.78 in the plot having 3 egg cards.

Overall mean of the data indicated that the plot having 4 egg cards provided better results showing lowest aphid population (7.69 aphids per tiller), followed by 8.78 with installation of 3 cards plot. Maximum aphid population (13.33 aphids per tiller) was found in the plot having 1 card. Significantly highest population (15.12 aphids per tiller) was found in control plot.

Percent Population Reduction: Data presented in Table 5 showed significant reduction in aphid population. The plot having 4 cards provided 49.50% reduction in aphid population, followed by 42.56% with installation of 3 Cards plot. Significantly lowest (12.33%) reduction in aphid population was found in the plot having 1 card.

According to (Freier *et al.*, 2007) reported that *C. carnea* larvae reduced the aphid infestation. Our results are quietly in line to (Shrewsbury *et al.*, 2000)concluded that in greenhouse study, release of 5 and 20 *C. carnea* larvae per plant showed 79 and 97% mortality of the pest respectively in green house. (Hemagirish *et al.*, 2001) noted 22.4% reduction in aphid population with the release of 1,75,000 2nd instar larvae of *C. carnea* /ha. (Farooq *et al.*, 2008) reported that release of tested predator (*C. carnea*) significantly reduced aphid population upto (59%) after one week and increased yield upto 4% over control. Our results are in quite agreement with (Iqbal *et al.*, 2008) who showed that tested predator reduced aphid population upto 30.68%.

Our findingsshowed that the plot having 4 egg cards showed lowest population (7.69 aphids /tiller) and maximum population reduction (49.50%). Maximum aphid population (13.33 per tiller) and lowest population reduction (12.33%) was found in the plot having 1card.

Chrysoperla carnea is a not only voracious predator but also can be known as aphid lion. The installation of 4 egg cards proved effective and highest reduction in aphid population was observed as compared to other treatments

Table 1. Aphid Population Captured on Yellow Sticky Traps at Different Intervals

No. of Traps	Aphid Population Captured on Yellow Sticky Traps					Mean
	Mar. 02	Mar. 09	Mar. 16	Mar. 23	Mar. 30	
4-Traps	1286.30 a	1410.30 a	854.33 a	510.00 a	179.33 a	848.07 a
3-Traps	949.00 b	1155.70 b	703.33 b	429.33 b	152.00 a	677.87b
2-Traps	675.30 c	895.70 c	499.67 c	316.00 c	98.00 b	496.93 c
1-Traps	370.30 d	446.30 d	251.67 d	163.33 d	55.00 b	257.33 d
CV	9.96	9.83	5.40	5.11	14.68	5.91
$LSD_{0.05}$	163.22	191.94	62.26	36.21	47.60	67.31

Means followed by the same letter (s) are non significantly different from each other

Table 2. Aphid Population in Wheat Field after Installation of Traps

No. of Traps	No. of Aphids / Tiller					Mean
	Mar. 02	Mar. 09	Mar. 16	Mar. 23	Mar. 30	
4-Traps	14.00 d	19.62 e	14.91 e	6.84 e	0.40 d	11.16 e
3-Traps	26.13 c	33.89 d	24.69 d	12.93 d	0.58 c	19.64 d
2-Traps	32.58 bc	50.04 c	30.51 c	16.53 c	0.73 b	26.08 c
1-Traps	37.84 b	64.80 b	38.13 b	25.26 b	0.80 b	33.37 b
Control	60.22 a	86.11 a	45.91 a	32.22 a	1.00 a	45.09 a
CV	11.35	8.65	4.54	5.92	10.15	3.27
$LSD_{0.05}$	7.3	8.29	2.63	2.09	0.13	1.67

Means followed by the same letter (s) are non significantly different from each other

Table 3. Reduction in Aphid after Installation of Yellow Sticky Traps

No. of Traps	Percent Reduction in Aphid Population					Mean
	Mar. 02	Mar. 09	Mar. 16	Mar. 23	Mar. 30	
4-Traps	76.62 a	77.22 a	67.51 a	78.71 a	59.58 a	71.93 a
3-Traps	56.08 b	60.66 b	46.11 b	59.77 b	42.04 b	52.93 b
2-Traps	45.71 bc	41.82 c	33.56 c	48.59 c	26.59 c	39.25 c
1-Traps	37.09 c	24.75 d	16.90 d	21.56 d	19.62 c	23.99 d
CV	10.28	11.56	7.58	5.59	14.64	3.10
$LSD_{0.05}$	11.07	11.81	6.21	5.83	12.23	2.91

Means followed by the same letter (s) are non significantly different from each other

Table 4. Grain Yield Affected by Installation of Different No. of Traps

No. of Traps	Yield (kg ha^{-1})
4-Traps	6617.9 a
3-Traps	6338.8 b
2-Traps	5990.5 c
1-Traps	5489.1 d
Control	5160.6 e
CV	1.13
$LSD_{0.05}$	51.13

Means followed by the same letter (s) are non significantly different from each other

Table 5 Role of *Chrysoperla Carnea* in Aphid Management in Wheat Crop

No. of Cards	No. of Aphids / Tiller						Population Reduction (%)
	Before Release	After Release				Mean	
		7 Days	14 Days	21 Days	28 Days		
4-Cards	3.58 a	20.98 d	10.87 e	2.49 d	0.51 c	7.69 e	49.50 a
3-Cards	3.48 a	22.47 d	14.07 d	2.98 d	0.78 b	8.78 d	42.56 b
2-Cards	3.60 a	28.40 c	18.24 c	5.40 c	0.96 b	11.32 c	25.39 c
1-Card	3.45 a	31.64 b	21.91 b	8.42 b	1.22 a	13.33 b	12.33 d
Control	3.62 a	35.31 a	24.82 a	10.40 a	1.38 a	15.12 a	----------
CV	8.78	5.87	6.86	10.88	11.37	1.33	3.00
$LSD_{0.05}$	0.58	3.07	2.32	1.21	0.20	0.28	1.47

Means followed by different letter (s) in a respective column are significantly different from each other

Conclusion

The following conclusion had been drawn from the current research.

Yellow sticky traps @ four traps/400 m^2 provided significant reduction in aphid population and release of *Chrysoperla carnea* @ four egg cards/5m^2 effectively suppressed aphid population.

Recommendations

Installation of yellow sticky traps @ four traps/400m^2 was effective and economical approach. Hence, recommended for the management of aphid in wheat crop. Also release of *Chrysoperla carnea* @ four egg cards/5m^2 is recommended against aphid in wheat field.

Competing Interests

Authors have declared that no competing interests exist.

References

Aheer, G., Irem, A., & Akhtar, M. (2017). Relationship of aphids and predators on different genotypes of wheat triticum aestivum under agri eco-system of bahawalpur. Journal of Agriculture Research (Lahore), **45**, 49-53.

Akhtar, I., & Khaliq, A. (2003). Impact of plant phenology and coccinellid predators on the population dynamic of rose aphid macrosiphum rosaeiformis das (aphididae: Homoptera) on rose. Asian Journal of Plant Sciences (Pakistan).

Anonymous. (2021-22). Pakistan economic survey. 21.

Anstead, J. A., Burd, J. D., & Shufran, K. A. (2003). Over-summering and biotypic diversity of schizaphis graminum (homoptera: Aphididae) populations on noncultivated grass hosts. Environmental Entomology, **32**(3), 662-667.

Anwar, J., Ali, M., Hussain, M., Sabir, W., Khan, M., Zulkiffal, M., & Abdullah, M. (2009). Assessment of yield criteria in bread wheat through correlation and path analysis. Journal of Animal and Plant Sciences, **19**(4), 185-188.

Aslam, M., Razaq, M., Akhter, W., Faheem, M., & Ahmad, F. (2005). Effect of sowing date of wheat on aphid (schizaphis gramium rondani) population. Pak Entomol, **27**(1), 79-82.

Bosque-Pérez, N. A., & Schotzko, D. J. (2000). Wheat genotype, early plant growth stage and infestation density effects on russian wheat aphid (homoptera: Aphididae) population increase and plant damage. Journal of Entomological Science, **35**(1), 22-38.

Burd, J., & Puterka, G. (2009). Plant resistance management strategies for greenbug [schizaphis graminum (rondani)](homoptera: Aphididae) in wheat-sorghum cropping systems. Redia, **92**, 227-228.

Cho, K., Eckel, C. S., Walgenbach, J. F., & Kennedy, G. G. (1995). Comparison of colored sticky traps for monitoring thrips populations (thysanoptera: Thripidae) in staked tomato fields. Journal of Entomological Science, **30**(2), 176-190.

El-Wakeil, N., & Volkmar, C. (2013). Monitoring of wheat insects and their natural enemies using sticky traps in wheat. Archives of Phytopathology and Plant Protection, **46**(13), 1523-1532.

Farooq, A., & Tasawar, Z. (2008). Evaluation of integrated management of aphid pests, brevicoryne brassicae and lipaphis erysimi on canola crop in southern punjab, pakistan. Pakistan Journal of Zoology, **40**(1).

Freier, B., Triltsch, H., Möwes, M., & Moll, E. (2007). The potential of predators in natural control of aphids in wheat: Results of a ten-year field study in two german landscapes. BioControl, **52**(6), 775-788.

Gu, X. S., Bu, W. J., Xu, W. H., Bai, Y. C., Liu, B. M., & Liu, T. X. (2008). Population suppression of bemisia tabaci (hemiptera: Aleyrodidae) using yellow sticky traps and eretmocerus nr. Rajasthanicus (hymenoptera: Aphelinidae) on tomato plants in greenhouses. Insect Science, **15**(3), 263-270.

Hassan, A., & Mohammed, A. (2004). Trapping efficiency of various colored traps for insects in cucumber crop under greenhouse conditions in riyadh, saudi arabia. Pakistan Journal of Biological Sciences, **7**(7), 1213.1216.

Hemagirish, M., Goud, K., & Mallapur, C. (2001). Utilization of chrysoperla carnea stephens in the management of safflower aphid, uroleucon compositae theobald. Karnataka Journal of Agricultural Sciences, **14**(3), 806-808.

Iqbal, J., Ashfaq, M., & Ali, A. (2008). Management of aphids by augmentation of coccinellids and chrysoperla carnea under field conditions on wheat. Pakistan Journal of Agricultural Sciences, **45**(1), 57-59.

Jansen, J. P. (2000). A three-year field study on the short-term effects of insecticides used to control cereal aphids on plant-dwelling aphid predators in winter wheat. Pest Management Science: formerly Pesticide Science, **56**(6), 533-539.

Jarošík, V., Honěk, A., & Tichopad, A. (2003). Comparison of field population growths of three cereal aphid species on winter wheat. Plant Protection Science, **39**(2), 61.

Junaid, K., Khan, S. A., Khan, I., Shah, S. R. A., & Khan, Z. (2016). Study on different components of resistance in wheat genotypes to green bug (schizaphis graminum)(rondani). Pakistan Journal of Zoology, **48**(4).

Kamran, A., Asif, M., Hussain, S. B., Ahmad, M., & Hirani, A. (2013). Major insects of wheat: Biology and mitigation strategies *Crop production*: IntechOpen.

Kausar, F., & Shahbaz, M. (2013). Interactive effect of foliar application of nitric oxide (no) and salinity on wheat (triticum aestivum l.). Pak. J. Bot, **45**, 67-73.

Kersting, U., & Başpmar, H. (1995). Seasonal and diurnal flight activity of circulifer haematoceps (hom., cicadellidae), an important leafhopper vector in the mediterranean area and the near east. Journal of applied Entomology, **119**(1-5), 533-537.

Khakwani, A. A., Dennett, M., Munir, M., & Abid, M. (2012). Growth and yield response of wheat varieties to water stress at booting and anthesis stages of development. Pak. J. Bot, **44**(3), 879-886.

Khan, A. M., Khan, A. A., Afzal, M., & Iqbal, M. S. (2012). Wheat crop yield losses caused by the aphids infestation. J Biofertil Biopestici, **3**(4), 2-7.

Kindler, S., Elliott, N., Giles, K., Royer, T., Fuentes-Granados, R., & Tao, F. (2002). Effect of greenbugs (homoptera: Aphididae) on yield loss of winter wheat. Journal of economic entomology, **95**(1), 89-95.

Kindler, S. D., Harvey, T. L., Wilde, G. E., Shufran, R. A., Brooks, H. L., & Sloderbeck, P. E. (2001). Occurrence of greenbug biotype k in the field. J. Agric. Urban Entomol, **18**(1), 23-34.

Kuroli, G. (2000). Aphid flight and change in abundance of winter wheat pests. Archives of Phytopathology & Plant Protection, **33**(4), 361-373.

Lu, Y., Bei, Y., & Zhang, J. (2012). Are yellow sticky traps an effective method for control of sweetpotato whitefly, bemisia tabaci, in the greenhouse or field? Journal of insect science, **12**(1), 113.

Mandour, N. S. (2009). Influence of spinosad on immature and adult stages of chrysoperla carnea (stephens)(neuroptera: Chrysopidae). BioControl, **54**(1), 93-102.

Memon, R. A., Bhatti, G. R., Khalid, S., Mallah, A., & Ahmed, S. (2013). Illustrated weed flora of wheat crop of khairpur district, sindh. Pak. J. Bot, **45**(1), 39-47.

Messina, F. J., & Sorenson, S. M. (2001). Effectiveness of lacewing larvae in reducing russian wheat aphid populations on susceptible and resistant wheat. Biological control, **21**(1), 19-26.

Miles, P. W. (1999). Aphid saliva. Biological reviews, **74**(1), 41-85.

Muhammad, W., Nasir, M., Abbas, S. K., Irshad, M., Abbas, M., Nawaz, A., & Rehman, A. (2013). Resistance pattern against aphid (diuraphis noxia) in different wheat varieties/lines at district layyah. Acad J Ent, **6**, 116-120.

Pappas, M., Broufas, G., & Koveos, D. (2007). Effects of various prey species on development, survival and reproduction of the predatory lacewing dichochrysa prasina (neuroptera: Chrysopidae). Biological Control, **43**(2), 163-170.

Senior, L., & McEwen, P. (2001). The use of lacewings in biological control. Lacewings in the crop environment, 296-302.

Shahzad, M. W., Razaq, M., Hussain, A., Yaseen, M., Afzal, M., & Mehmood, M. K. (2013). Yield and yield components of wheat (triticum aestivum l.) affected by aphid feeding and sowing time at multan, pakistan. Pak J Bot, **45**(6), 2005-2011.

Shanower, T. G., & Hoelmer, K. A. (2004). Biological control of wheat stem sawflies: Past and future. Journal of Agricultural and Urban Entomology, **21**(4), 197-221.

Shrewsbury, P. M., & Smith-Fiola, D. C. (2000). Evaluation of green lacewings for suppressing azalea lace bug populations in nurseries. Journal of Environmental Horticulture, **18**(4), 207-211.

Steffey, K., & Gray, M. (2012). Managing insect pests. Illinois agronomy handbook, 179-196.

Tauber, M. J., Tauber, C. A., Daane, K. M., & Hagen, K. S. (2000). Commercialization of predators: Recent lessons from green lacewings (neuroptera: Chrysopidae: Chrosoperla). American Entomologist, **46**(1), 26-38.