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Nitin Kumar Garg
M.Sc. Scholar, Department of Entomology, SHUATS, Prayagraj, Uttar Pradesh, India

Ashwani Kumar
Associate Professor and Head, Department of Entomology, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Nitin Kumar Garg
M.Sc. Scholar, Department of Entomology, SHUATS, Prayagraj, Uttar Pradesh, India

Comparative efficacy of certain chemicals and bio-pesticides against wheat aphid [*Sitobion miscanthi* (Takahashi)]

Nitin Kumar Garg and Ashwani Kumar

Abstract
A field investigation was conducted at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. During *Rabi* season 2021-22. The experiment was conducted in Randomized Block Design with eight treatments, replicated thrice. The data revealed that most effective treatments was Cypermethrin 10EC (70.09%) as compared to the untreated control, followed by Imidacloprid 17.8%SL (66.91%), Neem oil 0.03% (65.97%), Sixer plus (64.50%), *Metarizium anisopliae* (62.48%), *Verticilium lecanii* 1.15%WP (61.08%) and *Beauvaria bassiana* 1×109 CFU (59.04%) proved to be least effective. The highest yield and cost benefit ratio was recorded in Cypermethrin 10EC (49.6 q/ ha, 1:2.01) followed by Imidacloprid 17.8%SL (46.2 q/ ha, 1:1.82), Neem oil 0.03% (44.4 q/ ha, 1:1.71), Sixer plus (42.4 q/ ha, 1:1.45), *Metarizium anisopliae* (40.2 q/ ha, 1:1.33), *Verticilium lecanii* 1.15%WP (39.2 q/ ha, 1:1.40) and *Beauvaria bassiana* 1×109 CFU (37 q/ ha, 1:1.23) as compared to untreated control (31.2 q/ ha, 1:0.99).

Keywords: Comparative efficacy, bio-pesticide**,** chemicals, wheat aphid, *Sitobion miscanthi*

Introduction
Wheat (*Triticum aestivum* L.) is one of the most important staple food in India. It is a vital source of carbohydrate and contains important substance "gluten" which increases its demand for baking products. It provides about 20 per cent of the world's food calories and is a food for nearly 40per cent of world's population. India is the world's second largest wheat grower having an area 29.32 million ha and production of 95.9 million tones.

The aggregate area under wheat production in the world is about 250.9 million ha with an overall production of 772.64 milliontons. According to the Agriculture Ministry, wheat was cultivated on a record 34.63 million hectares compared with 33.64 million hectares last year. In the last 10 years, the normal wheat acreage has been 30.32 million hectares. Major wheat growing states in India are UttarPradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar and Gujarat. India's partake in world wheat area is about 12.40%, whereas it occupies 11.77% partake in the total world wheat production.

The world's population is continuously increasing and is projected to be more than 9 billion by 2050. This population growth is co-happening with other elements such as a dietary shift in developing countries, environmental change, increasing pest population, which is compromising wheat yields due to abiotic factors, and the constant pressures of biotic hassles (Matharu *et al*., 2019) [7]. Among the biotic factors that limit wheat production, aphid complex is considered as a major threat, which significantly reduces grain yields if not controlled. Aphids are serious pests worldwide, able to bring about severe damage in cereal crops, especially wheat, *Triticum aestivum*, by direct feeding and by transmitting plant pathogenic viruses (Peairs *et al*., 2008) [9].

In India, wheat (*Triticum aestivum*) is attacked by more than 11 aphid species, out of which four species namely *Sitobion avenae* (fabricius), *Sitobion miscanthi* and *Rhopalosiphum maidis* are reported to be most predominant and a combined population of these four is designated as wheat aphid complex. Wheat aphid cause direct damage by sucking the cell sap, especially during the milky grain stage and also duo to the development sooty mould on plant leaves. Population of aphid varies every year with prevailing climatic conditions and wheat cultivars; therefore the monitoring is necessary throughout the year. (Shafique and Ahmed, 2016) [11].

They cause direct damage by sucking cell sap of leaves, young shoots, causing distortion, stunting, leaf curling, wilting and twisting. Indirect damage by depositing honey dew that reduce photosynthetic activity and induce sooty mould production and premature leaf senescence further pause serious losses. *Beauveria bassiana* and *Metarhizium anisopliae* in particular have wide host range (Khan *et al*., 2002) [5]. Distributed in all regions of the world and can be easily isolated from insects and soil. They appear mostly from December to January has as reported 10 to 50% reduction in crop yield due to aphid infestation. Management of aphids has been primarily done using chemical methods, resulting in serious environmental and health problems, wide spread use of synthetic pesticides and demanding crop production causes several socio-economic problems throughout the world (Patil *et al*., 2015) [8].

Materials and Methods

The experiment was conducted at the experimental research plot of the Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences, during the *Rabi* season of 2021-22 in a Randomized Block Design with eight treatments including an untreated control, each with three replication. The SUPER-303 variety of wheat was used and a healthy crop was raised by following all the recommended agronomical practices. The plot size was 2m x 2m and the spacing between rows and plants was maintained at 22.5cm. The site selected for experiment was uniform, cultivable with typical sandy loam oil having good drainage. The observation on population of sucking pest were recorded visually using a magnifying lens early on the top 10 cm central apical twig per plant from five randomly selected and tagged plants in each plot. Aphid count was taken 24 Hours before spraying at 5 randomly selected plants per plot, which was further converted into per plant population and subsequent observation was recorded at 3rd, 7th and 14th days after spraying. The formula used for the calculation of percentage reduction of pest population over control using following formula giving by Henderson and Tilton (1955) [13] referring it to be modification of Abbott (1925) [14].

Percent population reduction analysis

Percent population reduction on aphid was calculated with the following formula suggested by (Abbot, 1925) [14].

$$\text{Percent population reduction} = \frac{C\text{-}T}{C} \times 100$$

Where,
C = Population in untreated check plot
T = Population in treated plot

Results and Discussion

The data so obtained through observation on various aspects were subjected to statistical analysis wherever necessary and the compiled mean data are tabulated in the following pages. Results, thus obtained are presented aspect wise here under.

The results presented in Table - 1 revealed that three days after first spray, highest per cent of aphid population reduction was recorded in T7 Cypermathrin 10EC (43.23 %) followed by T5-Imidacloprid 17.8%SL (41.00 %), T4- Neem oil 0.03% (39.66%), T3- Sixer plus (38.10%), T6-*Metarhizium anisopliae* (36.03 %),T1-*Verticilium lacanii 1.15%WP* (34.67 %) and T2-*Beauvaria bassiana 1×109 CFU* (32.51 %). Seventh days after first spray, highest per cent of aphid population reduction was recorded in T7 Cypermethrin 10 EC (68.32 %) followed by T5-Imidacloprid 17.8% SL(65.92 %), T4- Neem oil 0.03% (63.22 %),T3- Sixer plus (61.28 %), T6-*Metarhizium anisopliae* (59.77 %), T1-*Verticilium lacanii 1.15% WP* (58.43 %) andT2-*Beauvaria bassiana 1×109 CFU*(56.69 %). Fourteen days after firstsprayT7 Cypermathrin 10 EC (73.55 %) followed by T5-Imidacloprid 17.8% SL (69.85 %),T4- Neem oil 0.03% (69.42 %),T3- Sixer plus (68.09 %),T6-*Metarhizium anisopliae* (65.85 %),T1- *Verticilium lacanii 1.15%WP* (64.31 %) and T2-*Beauvaria bassiana 1×109 CFU* (62.46%).The results revealed the Percent population reduction Mean of first spray, T7 Cypermathrin 10 EC (61.70%) followed by T5-Imidacloprid 17.8% SL (58.92 %), T4- Neem oil 0.03% (57.43 %),T3- Sixer plus(55.82 %), T6-*Metarhizium anisopliae* (53.81 %),T1- *Verticilium lacanii 1.15% WP* (52.47%) T2-*Beauvaria bassiana* 1×109 CFU (50.55 %).

The results presented in Table - 1 revealed that three days after second spray, T7 Cypermethrin 10 EC (76.67 %) followed by T5-Imidacloprid 17.8% SL (73.12 %), T4- Neem oil 0.03% (72.71%), T3- Sixer plus (71.42%), T6-*Metarhizium anisopliae* (69.26%),T1- *Verticilium lacanii* 1.15%WP (67.77 %) and T2-*Beauvaria bassiana* 1×109 CFU (65.81 %). Seventh days after first spray, T7 Cypermethrin 10 EC (78.48 %) followed by T5- Imidacloprid 17.8% SL(74.78 %), T4- Neem oil 0.03% (76.33 %),T3- Sixer plus (73.27 %), T6-*Metarhizium anisopliae* (71.16 %),T1-*Verticilium lacanii 1.15%WP* (69.71 %) and T2- *Beauvaria bassiana* 1×109 CFU (67.66 %). Fourteen days after first sprayT7 Cypermethrin 10 EC (80.31 %) followed by T5-Imidacloprid 17.8% SL (76.82 %),T4- Neem oil 0.03% (76.37%), T3- Sixer plus (74.87 %), T6-*Metarhizium anisopliae* (73.18%), T1-*Verticilium lacanii 1.15%WP* (71.60 %) and T2-*Beauvaria bassiana* 1×109 CFU (69.16 %). The results revealed the Percent population reduction Mean of first spray, T7 Cypermathrin 10 EC (78.48%) followed by T5-Imidacloprid 17.8% SL (74.90 %), T4-Neem oil 0.03% (74.51 %),T3- Sixer plus(73.18 %), T6-*Metarhizium anisopliae* (71.16 %),T1-*Verticilium lacanii* 1.15%WP (69.69%) T2-*Beauvaria bassiana* 1×109 CFU (67.54 %).

Overall mean of per cent population reduction (3rd, 7th and 14th DAS) of two sprays

The data on the mean (3rd, 7th & 14th) **Overall mean** per cent population reduction after two spray, revealed that T7 Cypermethrin 10 EC (70.09%) was most effective treatment against wheat aphid followed by T5-Imidacloprid 17.8% SL (66.91%), T4- Neem oil 0.03% (65.97%),T3- Sixer plus(64.50%), T6-*Metarhizium anisopliae* (62.48%), T1-*Verticilium lacanii 1.15%WP*(61.08%), T2-*Beauvaria bassiana* 1×109 CFU (59.04%). Among all the treatments T2-*Beauvaria bassiana* 1×109 CFU (59.04%) was least effective treatment against wheat aphid.

Table 1: Comparative efficacy of certain chemicals and bio-pesticides against wheat aphid [*Sitobion miscanthi* (Takahashi)] during Rabi season 2021-22.

Tr. No	Treatments	Per cent population reduction of *Sitobion miscanthi* / 5 plan								Mean	Overall Mean	Yield (q/ha)	B:C ratio
		1st spray					2nd spray						
		1DBS	3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS				
T1	*Verticilium lecanii* 1.15%WP	27.26	34.67	58.43	64.31	52.47	67.77	69.71	71.60	69.69	61.08	39.2	1:1.40
T2	*Beauvaria bassiana* 1×109 CFU	27.93	32.51	56.69	62.46	50.55	65.81	61.66	69.16	67.54	59.04	37	1:1.23
T3	Sixer plus	25.86	38.10	61.28	68.09	55.82	71.42	73.27	74.87	73.18	64.50	42.4	1:1.45
T4	Neem oil 0.03%	27.06	39.66	63.22	69.42	57.43	72.71	74.49	76.37	74.51	65.97	44.4	1:1.71
T5	Imidacloprid 17.8%SL	26.53	41.00	65.92	69.85	58.92	73.12	74.78	76.82	74.90	66.91	46.2	1:1.82
T6	*Metarizium anisopliae*	25.53	36.01	59.57	65.85	53.81	69.26	71.16	73.06	71.10	62.48	40.2	1:1.33
T7	Cypermethrin 10EC	24.86	43.23	68.32	73.55	61.70	76.67	78.48	80.31	78.48	70.09	49.6	1:2.01
T0	Control	25.46	0	0	0	0	0	0	0	0	0	31.2	1:0.99
	F- test	NS	S	S	S	S	S	S	S	S	**S**		
	S.Ed (+/-)	N/A	2.92	2.32	0.91	4.57	0.96	0.6	0.67	0.52			
	C.D at 5%		6.28	4.99	1.96	9.81	1.87	1.29	1.46	1.13			

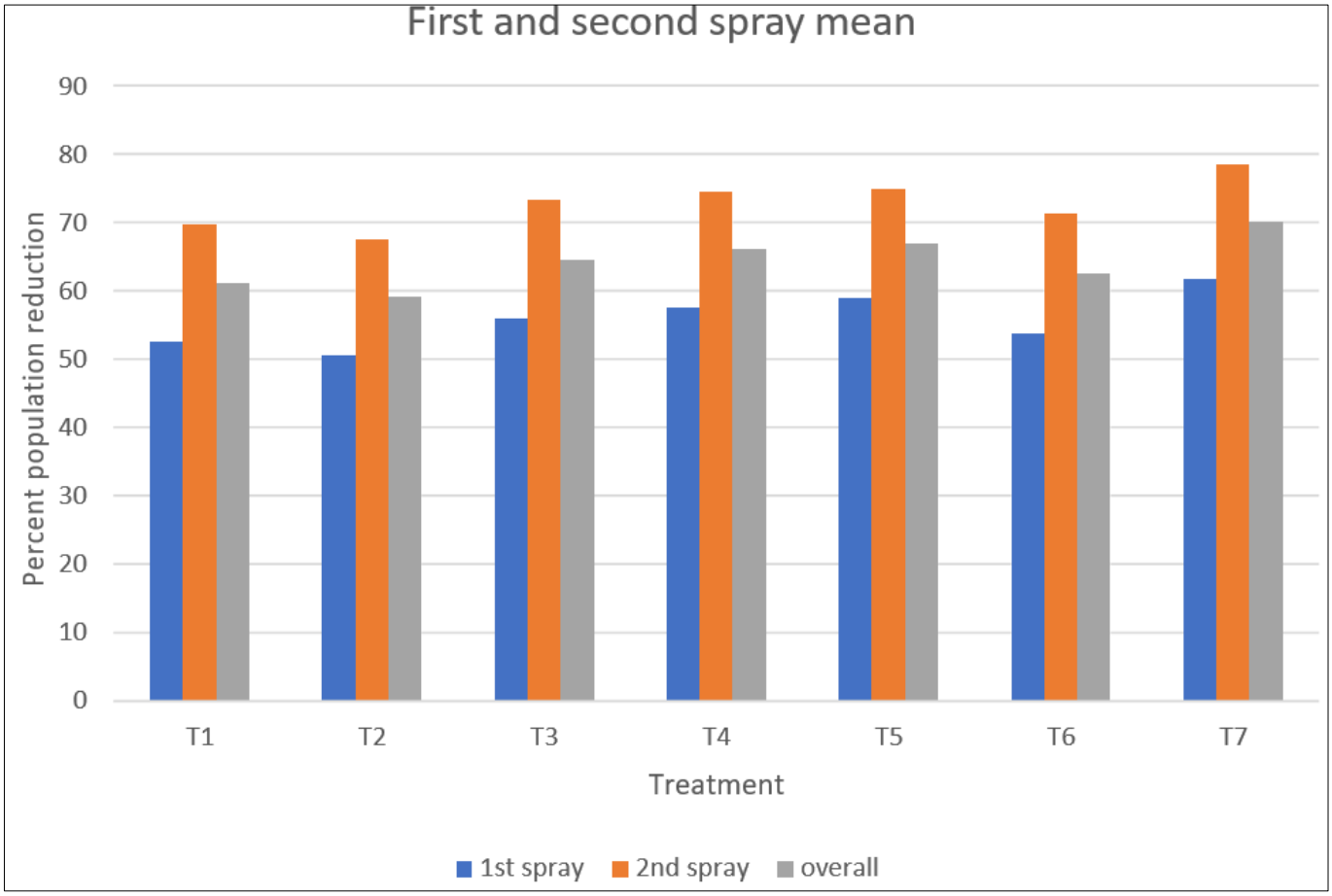

Fig 1: Comparative efficacy of certain chemicals and bio-pesticides against wheat aphid [*Sitobion miscanthi* (Takahashi)] during Rabi season 2021-22. (First and Second Spray)

Discussion

All the insecticides was found effective and significantly superior over untreated control. The highest per cent population reduction of wheat aphid was recorded in T7 Cypermethrin 10EC (70.09%) as the similar findings was reported by Rathore *et al*., (2016) [10], T5- Imidacloprid 17.8%SL was found to be the next effective treatment with a per cent population reduction (66.91%) as the similar findings was reported by Safique *et al*., (2016) [15] 97.13%. T4- Neem oil 0.03% was found as the next effective treatment (65.97%) as the similar findings was reported by Aziz *et al*., (2013) [2] 77.56%. T3- Sixer plus was found to be the next effective treatment (64.5%) as the similar findings was reported by Gayathri and Kumar (2021) [3]. T6- *Metarizium anisopliae* was the next effective treatment (62.48%) as the similar findings was reported by Kumar *et al*., (2020) [6] 47.33% Patil *et al*., (2015) [8]. T1- *Verticilium lecanii* 1×1.15%WP was the next effective treatment (61.08%) as the similar findings was reported by Kumar *et al*., (2020) [6] (42.30%). T2- *Beauvaria bassiana* 1×109 was the next effective treatment (59.04%) as the similar findings was reported by Kumar *et al*., (2020) [6] (42.30%).

The yield among the treatment was significant. The highest yield was recorded in Cypermethrin10EC (49.6 q/ha) followed by Imidacloprid 17.8%SL (46.2 q/ha) Shah *et al*., (2017) [12], Matharu *et al*., (2019) [7] (51.55 q/ha), Ahmad *et al*., (2016) [1] (32.65 q/ha), Neem oil 0.03% (44.4 q/ha) Aziz *et al.* (2013) [2], Sixer plus (42.4 q/ha) Gayathri and Kumar

(2021) [3], *Metarhizium anisopliae* (40.2 q/ha) Patil *et al*., (2015) [8] (45.06 q/ha), *Verticilium lecanii* 1.15% WP (39.2 q/ha) Patil *et al*., (2015) [8] (44.87 q/ha), and *Beauvaria bassiana* 1 × 109 CFU (37 q/ha) Patil *et al*., (2015) [8] (44.78 q/ha) as compared to control (31.2 q/ha).

Cost benefit ratio

After calculating, the highest Cost: Benefit ratio was recorded in the treatment Cypermethrin 10EC (1:2.01) followed by Imidacloprid 17.8%SL (1:1.82) Aziz *et al*., (2013) [2] (1:1.34), Matharu *et al*., (2019) [7] (1:6.65), Ahmad *et al*., (2016) [1], Neem oil 0.03% (1:1.71) Aziz *et al*., (2013) [2] (1:1.34), Sixer plus (1:1.45) Gayathri and Kumar (2021) [3], *Metarhizium anisopliae* (1:1.33) Katare *et al*., (2018) (1:2.66) Patil *et al*., (2015) [8] (1:2.59), *Verticilium lecanii* 1.15% WP (1:1.40) Patil *et al*., (2015) [8] (1:2.58) and *Beauvaria bassiana* 1×109CFU (1:1.23) Patil *et al*., (2015) [8] (1:2.55) as compared to control (1:0.99).

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