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Efficacy of microbial and chemical pesticides against wheat aphid (*Rhopalosiphum padi* L.)

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Abstract
Field experiment on Efficacy of microbial and chemical pesticides against wheat aphid (*Rhopalosiphum padi* L.) was conducted during *rabi* season of 2018-19 on wheat crop at Agricultural Research Station, Niphad, Dist. Nasik. The present investigation was carried out with an object to study the efficacy of biopesticides and chemical insecticides against wheat aphid (*R. padi*) at alone and its alternate application, to identify highly effective biopesticides and chemical insecticides schedules for the management of wheat aphid Studies on efficacy of microbial and chemical pesticides against wheat aphid revealed that among the treatment schedules of chemical insecticide followed by chemical insecticide, biopesticide followed by chemical insecticide and biopesticide followed by biopesticides, the most promising schedules were thiamethoxam 25 WG @ 50.0g/ha fb. thiamethoxam 25 WG @ 50.0g/ha and thiamethoxam 25 WG @ 50.0g/ha fb. diamethoate 30 EC @ 750ml/ha which significantly reduced the aphid population which recorded 0.00, 0.00 & 7.53 and 0.00, 0.00 & 8.23 number of aphid/shoot/plant at 3, 7 and 14 days after spray, respectively. Treatments schedule with *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0g/ha was the next promising treatments which recorded 10.07 number of aphid/ shoot/ plant on an average basis. It was at par with *Metarhizium anisopilae* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0g/ha (10.35).

Keywords: Aphid, wheat, biopesticides, insecticides

Introduction
Wheat is the leading grain of the world and is grown wherever climatic and soil conditions are favorable in the temperate zone, especially in North America, Europe, China, North West India, Argentina and Australia. Wheat belongs to family *Poaceae* (*Gramineae*). The chromosome number sets (genomes) for wheat are diploids 14 (n=7), tetraploids 28 (n=14) and the hexaploids 42 (n=21). There are 50 wild species of wheat, out of which four species *viz. Triticum aestivum, Triticum durum, Triticum diccocum* and *Triticum sphaerococcum* are under cultivation in India. *Triticum aestivum* is the most important species occupying more than 90 per cent of the total wheat area in country followed by *Triticum durum* (8-9%) and *Triticum dicocum* (< 1%). *Triticum sphaerococcum* has now practically not cultivated because of its low productivity and high susceptibility to diseases. Nearly 344 wheat varieties (291 *T. aestivum*, 46 *T. durum*, 4 *T. dicoccum* and 3 *T. triticale*) have been released so far in India.
In India wheat is grown in almost all states. The important wheat growing states are Bihar, Jharkhand, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Uttar Pradesh, Uttrakhand and West Bengal. In India it occupies an area of 30.42 million hectare with a production and productivity of 98.38 million tonnes and 3172 kg/ha, respectively and accounts for about 38% of the country's total food grain production (Anonymous, 2018) [2]. Wheat is one of the important *rabi* crop of Maharashtra. In Maharashtra it is grown on area of 08.00 lakh hectare with a production and productivity of 12.07 lakh tonnes and 1508 kg/ha, respectively during *rabi* 2017-18 (Anonymous, 2018) [2].
Wheat is grown primarily as a food crop, its plant, seed, straw, and bran are used in industrial products as well as a feed of livestock. Wheat straw is used as fuel, animal bedding, and organic matter for soil (Wiese, 1987) [11]. In India, the largest cropped area is devoted to wheat and the quantity produced is more than that of any other crop. Globally, wheat occupied first position in production among cereals.
India is still struggling to become self-sufficient in wheat production. This is possible when the gap between the potential yield of this crop and the actual yield obtained by the growers in this country is filled. This gap is attributed to the lack of appropriate production technology and attack by a variety of insect pests species. The crop is infested by a number of insect pests, *viz.*, armyworm, *Mythimna separata* (Haworth); ghujhia weevil, *Tanymecus indicus* (Faust);

Termite, *Odontotermes obesus* (Ramb.); cutworms, *Agrotis spp.;* shoot fly, *Atherigona naquii* (Styskal); pink borer, *Sesamia inferens* (Walker); Jassid, *Amrasca basalis* (Baly); and, aphid. Among these insect pests, the aphid is most serious and regular insect pest of this crop.

Aphid (Homoptera: Aphididae) are sucking insect pests of various field crops. These are important and economic pests of about 60 plant species including wheat, barley, sorghum and corn. Three species of cereal aphid were recorded on wheat varieties including Bird cherry oat aphid, *Rhopalosiphum padi* (Linnaeus), Corn leaf Aphid, *Rhopalosiphum maidis* (Fitch) and green bug, *Schizaphis graminum* (Rondani). The population of *R. padi* was the most abundant and it was the most important aphid species on wheat whose occurrence interfered with grain formation and grain filling (Kannan, 1997) [7]. Aphid is major pests of the crops causing wheat yield loss in many parts of the world. Most of them because of parthenogenesis, viviparation and polymorphism have very high reproduction rate in the absence of natural enemies. These insects become mature in a short time, so they can significantly increase its population in less time (Carver, 1989) [5].

Aphid pierce and suck sap from leaves, stems, and less frequently the developing kernels of wheat. Some inject toxic substances that destroy plant tissue while some are vectors of viruses that may cause widespread losses exceeding those attributed to the direct feeding damage (Gair *et al.*, 1983) [6]. One of the important aphid species is wheat aphid, *Rhopalosiphum padi* although many insect pests in India attack wheat crop but aphid is the most damaging agent. The damage due to aphid is reported in many field is now known as a regular pest of wheat due to a dramatic increase in its population on wheat crop and is found responsible for as high as 50% reduction in grain weight per earhead. Their incidence is increasing day by day and had attained the status of a regular pest. On average, about 72% losses due to aphid attack were attributed to their direct sap sucking and remaining 28% were due to fungal growth favored by their honeydew secretions. Aphids have been found affecting wheat production adversely causing 35-40% direct and 20-80% indirect yield losses by transmission of viral and fungal diseases. The decline in grain yield in various genotypes, ranging from 7.9 to 34.2% has also been reported by (Lal *et al*., 2010) [8]. Aphid incidence is reported variable among different wheat cultivars and also depends on crop stage. It is better to utilize varietal resistance of wheat cultivars along with judicial use of appropriate insecticides application against aphid.

Material and Methods

The present investigation entitled, Efficacy of microbial and chemical pesticides against wheat aphid (*Rhopalosiphum padi* L.) was carried out during *rabi* season of 2018-19 under field condition at the research farm of Agricultural Research Station, Niphad Dist. Nashik, Maharashtra to find out highly effective biopesticides, chemical insecticides and combination of alternate application of biopesticides and chemical insecticides for the management of wheat aphid.

Materials Seeds

Seed of wheat variety NIDW 295 (Godavari) were obtained from Wheat specialist, Agricultural Research Station, Niphad, Dist. Nashik

Biopesticides

The biopesticides were obtained from the Biocontrol unit of Department of Agricultural Entomology, MPKV, Rahuri and chemical pesticide was purchased from the market.

Table 1: Details of biopesticides and chemical insecticides

S. No.	Particulars	Formulation	Dose/ha	Trade name	Manufacturer or source
1.	*Lecanicillium lecanii* 1.15% WP	Wettable powder $1x10^8$cfu/ml	2.50 kg	Phule Bugicide	Biocontrol unit, Dept. Of Agril Entomology, MPKV, Rahuri
2.	*Metarhizium anisopliae* 1.15% WP	Wettable powder $1x10^8$cfu/ml	2.50 kg	Phule *Metarhizium*	Biocontrol unit, Dept. Of Agril Entomology, MPKV, Rahuri
3.	Thiamethoxam 25 WG	Wettable granules (WG)	50 g	Actara	Syngenta India Ltd., Mumbai.
4.	Diamethoate 30 EC	Emulcifiable concentration (EC)	1000 ml	Rogor	Isagro (Asia) Agrochemicals Pvt. Ltd., Mumbai.

Chemical Insecticides

The chemical insecticides were purchased from the market. The details of biopesticides and chemical insecticides used for the experiment with their common name, trade name, formulation and source are given in Table 1.

Observations on pest of wheat and their natural enemies

i) **No. of aphid:** Pre count and post count were recorded on tagged five shoots from each five randomly selected plants per treatment. Pre count was recorded at 24 hours before spray. Post count observations on survival aphid were recorded at 3, 7 and 14 days after each spray.

Grain yield data

Harvesting was done at 130 days after sowing. The treatment wise total yield was recorded kg/plot and converted it into q/ha.

Incremental cost benefit ratio

The economics of each treatment were worked out and the incremental cost benefit ratio of each treatment was calculated by taking into account the prevailing market price of input produced and labour charges.

Statistical Analysis

The data on observations of pests were subjected to statistical analysis. The different treatment means were separated using least significant difference test at p=0.05. The percentage data subjected to arc sin transformation and population as square root transformation whenever needed. The correlation between aphid population and different weather parameters were also worked out.

Results and Discussion

The results of present studies on "Efficacy of microbial and chemical pesticides against wheat aphid (*Rhopalosiphum padi*

L.) With an objectives to study the efficacy of biopesticides and chemical insecticides against wheat aphid (*Rhopalosiphum padi* L.) at alone and its alternate application
The data on average survival population of aphid/shoot/plant revealed the significant differences. All the treatment schedules were found significantly superior in checking the aphid population at 3, 7 and 14 days after spray. The result in respect of the trend of the efficacy of various treatment schedules were more or less same at 3, 7 and 14 days after spray. At 3, 7 and 14 days after spray the most promising treatment schedules were thiamethoxam 25 WG @ 50.0 g/ha fb. thiamethoxam 25 WG @ 50.0 g/ha and thiamethoxam 25 WG @ 50.0 g/ha fb. diamethoate 30 EC @ 750 ml/ha which recorded 0.00, 0.00 & 8.23 and 0.00, 0.00 & 7.53 number of aphid/shoot/plant at 3, 7 and 14 days after spray, respectively. Treatment schedule with *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0 g/ha was the next promising treatment which recorded 10.04 number of aphid/shoot/plant at 3 days after spray. It was at par with *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0 g/ha (10.44).
At 14 days after spray treatment schedule with thiamethoxam 25 WG @ 50.0 g/ha fb. diamethoate 30 EC @ 750 ml/ha recorded significantly minimum of 7.53 number of aphid/shoot/plant and it was at par with thiamethoxam 25 WG @ 50.0 g/ha fb. thiamethoxam 25 WG @ 50.0 g/ha (8.23) followed by *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha fb. *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha (14.74), *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha fb. *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha (15.00), *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha fb. *Lecanicillium lecanii* 1.15% WP @2.0 kg/ha (15.07), *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0 g/ha (15.50) and *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0 g/ha (15.97). The untreated control recorded the highest of 78.50, 94.07 and 122.34 number of aphid/shoot/plant at 3, 7 and 14 days after spray, respectively.
From the average mean population of aphid of 3, 7 and 14 days, the treatment schedule with thiamethoxam 25 WG @ 50.0 g/ha fb. diamethoate 30 EC @ 750 ml/ha (2.51) was emerged as the most effective in controlling the aphid population. The next succeeding effective was thiamethoxam 25 WG @ 50.0 g/ha fb. thiamethoxam 25 WG @ 50.0 g/ha (2.74) i.e. also chemical followed chemical. The next effective treatment schedule in descending order were *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0 g/ha (10.07) i.e. biopesticides followed followed by chemical insecticides, *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0 g/ha (10.35) i.e. biopesticieds followed by chemical, *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha fb. *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha (12.18) i.e. biopesticides followed by biopesticides, *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha fb. *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha (12.28) i.e. biopesticides followed by biopesticides and *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha fb. *Lecanicillium lecanii* 1.15% WP @ 2.0 kg/ha (12.63) i.e. biopesticides followed by biopesticides.

Table 2: Cumulative effect of microbial and chemical insecticides on survival population of wheat aphid (average of two sprays)

S. No.	Treatment details	Dose formulated product /ha	Survival population of aphid/shoot/plant at				Mean
			Pre count	3 DAS	7 DAS	14 DAS	
T_1	*Lecanicillium lecanii* 1.15% WP fb. *Lecanicillium lecanii* 1.15% WP	2.0 kg- 2.0 kg	35.37 (6.03)	18.40 (4.40)	5.67 (2.58)	15.07 (4.00)	12.63 (3.69)
T_2	*Metarhizium anisopliae* 1.15% WP fb. *Metarhizium anisopliae* 1.15% WP	2.0 kg - 2.0 kg	35.34 (6.03)	15.04 (4.00)	4.40 (2.32)	14.74 (3.97)	12.18 (3.63)
T_3	Thiamethoxam 25 WG fb. thiamethoxam 25 WG	50.0 g- 50.0 g	27.23 (5.31)	0.00 (1.00)	0.00 (1.00)	8.23 (3.04)	2.74 (1.93)
T_4	Thiamethoxam 25 WG fb. diamethoate 30 EC	50.0g - 750ml	27.40 (5.33)	0.00 (1.00)	0.00 (1.00)	7.53 (2.92)	2.51 (1.87)
T_5	*Lecanicillium lecanii* 1.15% WP fb.thiamethoxam 25 WG	2.0 kg- 50.0 g	35.70 (6.06)	10.44 (3.38)	3.80 (2.19)	15.97 (4.12)	10.07 (3.33)
T_6	*Metarhizium anisopliae* 1.15% WP fb. thiamethoxam 25 WG	2.0 kg- 50.0 g	35.44 (6.04)	10.04 (3.32)	5.50 (2.55)	15.50 (4.06)	10.35 (3.37)
T_7	*Lecanicillium lecanii* 1.15% WP fb. *Metarhizium anisopliae* 1.15% WP	2.0 kg- 2.0 kg	35.50 (6.04)	16.73 (4.21)	6.24 (2.69)	15.00 (4.00)	12.28 (3.64)
T_8	Untreated control	--	70.44 (8.45)	78.50 (8.92)	94.07 (9.75)	122.34 (11.06)	98.30 (9.96)
	SE +		0.09	0.09	0.10	0.08	--
	CD at 5%		0.28	0.29	0.31	0.25	--

- DAS- Days after spray
- Fb.-followed by
- Figures in parentheses indicate √x+1 transformed value

Wheat aphid is one of the most serious pest of wheat. It sucks the cell sap from leaves and stem. The survival population of aphid after spraying of insecticides was used to judge the efficacy of various insecticide/biopesticides schedules against aphid. The result of trial indicates that the treatment schedule with thiamethoxam 25 WG @ 50.00 g/ha fb. dimethoate 30EC @750ml/ha was emerged as the most effective in controlling population of aphid. It was followed by thiamethoxam 25 WG @ 50.00 g/ha fb. thiamethoxam 25WG @ 50.00 g/ha. i.e. chemical insecticide followed by chemical insecticide. The present result in respect of efficacy of thiamethoxam 25WG against wheat aphid in conformity with those reported by Patil *et al.* (2016) and Shukla and Pathak (2000).
Among the treatment schedule of biopesticides fb. Chemical insecticides and biopesticide fb. biopesticides, *Lecanicillium lecanii* 1.15 WP @ 2.00 kg/ha fb. Thimethoxam 25 WG @ 50.00 g/ha, *Metarhizium anisopliae* 1.15 WP @ 2.00 kg /ha fb. Thimethoxam 25 WG @ 50.00 g/ha. i. e. biopesticides followed by chemical insecticides were found most effective

against aphid on wheat. The result in respect on bioefficacy of *Lecanicillium lecanii* and *Metarhizium anisopliae* found in conformity with those reported by Patil *et al.* (2015) who reported that the effectiveness of *Metarhizium anisopliae* 1.15 WP @4g/lit. and *Lecanicillium lecanii* 1.15 WP @ 4 g/lit. against wheat aphid and resulting maximum yield of wheat grains. Similar result inconformity with present finding were also reported by Ghortale S. R. (2015).

Similar results of chemical insecticides *viz*. imidachloprid, clothiamidin i.e. neonicotinoids were repoted by Burd *et al.* (1996) [4], Gray (1996), Ahmed *et al*. (2001) [1], Mhaske *et al.* (2007) [9], Babu *et al.* (2012) [3] and Shahazad *et al*. (2013) on wheat against wheat aphid.

Conclusion

With reference to above results, it could be concluded that

- Among the treatment schedules of chemical insecticide followed by chemical insecticide and biopesticides followed by chemical insecticide and biopesticides followed by biopesticides with thiamethoxam 25 WG @ 50.0 g/ha fb. thiamethoxam 25 WG @ 50.0 g/ha, thiamethoxam 25 WG @ 50.0 g/ha fb. diamethoate 30 EC @ 750 ml/ha were found significantly superior for the control of aphid on wheat.
- Among the treatment schedules of biopesticides followed by chemical insecticides and biopesticides followed by biopesticides with *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha fb. thiamethoxam 25 WG @ 50.0 g/ha was found effective for controlling the aphid on wheat.
- Among the treatment schedules of biopesticides followed by biopesticides with *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha fb. *Metarhizium anisopliae* 1.15% WP @ 2.0 kg/ha was found effective for controlling the aphid on wheat.

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