Forage Res., **49**(2) : pp. 218-223 (2023) **http://forageresearch.in**

EFFICACY OF MICROBIAL AND BOTANICAL PESTICIDES AGAINST APHID (*RHOPALOSIPHUM PADI* L.) ON OAT (*AVENA SATIVA* L.) IN MAHARASHTRA

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(Received : 19 August 2023; Accepted : 21 September 2023)

SUMMARY

The present experiment on efficacy of microbial and botanical pesticides against aphid (*Rhopalosiphum padi* L.) was conducted during *Rabi* season of 2016-17 to 2019-20 on oat crop at the field of All India Coordinated Research Project on Forage Crops & Utilization at MPKV, Rahuri Dist- Ahmednagar, Maharashtra. Winter fodder scarcity is one of the major problems in feeding management for ruminants in India. Oat (*Avena sativa* L.) belong to gramineae family is one of the important cosmopolitan forage crop in the world agriculture ecosystem due to its quick growing habit, multi-cut ability and high protein content. Oat crop are heavily attacked by aphids. This aphids are found causing damage by pierce and suck sap from leaves, stems and hence responsible for the quality and yield losses. The present investigation was carried out with an object to "study the efficacy of biopesticides and botanical insecticides against oat aphid (*R. padi*)" to find out highly effective biopesticides for the management of oat aphid and to avoid the residues due the chemical insecticides. In the study oat variety Kent was sown at 25 cm spacing as line sowing in 3 × 4 m plot size with randomized block design with three replications and each replication has five rows. Studies revealed that among the treatment of biopesticide, at 7 days after treatment, *L. lecanii* @ 7.5 g/lit recorded significantly lower number of survived aphids per tiller 8.77 followed by *M. anisopilae* @ 7.5 g/lit (10.49), *L. lecanii* 5g/lit (10.54), and *M. anisopilae* @ 5 g/lit.(13.75). Similarly the higher Green Forage Yield recorded in *L. lecanii* 1.5 % @ 7.5 g/lit. (502.07 q/ha) followed by *M. anisopliae* @ 7.5 g/lit (497.37 q/ha), *L. lecanii* @ 5g/lit (496.75 q/ha) and *M. anisopliae* @ 5 g.lit (495.03 q/ha). Among the treatments there were found non significant differences of coccinellid predators. Biopesticides did not affect the activities of coccinellid predators at 5 and 7 days after spray.

Keywords: Oat, aphid, biopesticides, management

Oat (*Avena sativa* L.) belongs to gramineae family is one of the important cosmopolitan forage crops in the world agriculture ecosystem. Oat ranks sixth in the world cereal production following wheat, maize, rice, barley and sorghum (Pandey and Roy, 2011). Oat is multipurpose cereal used primarily for animal feed, human food and industrial purpose. It is cultivated all over the world and major producing countries are Russia, Canada, Poland and USA. The average annual production is around 23 million tonnes per year. In India oat is most important winter cereal fodder crop grown in North as well as Central India and is now extending to eastern region. It has excellent growth habit, quick recovery after cutting and good quality herbage. It is palatable, succulent and nutritious fodder crop & excellent protein quality. The importance of oats in the biochemical and cosmetic industry is also on the rise (Tiwari and Cummins, 2009). Out of cereals, the highest amounts of β-glycan are found in oats grains (Ahmad and Zaffar, 2014). It is cultivated in Punjab, Haryana, West Bengal, Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan and Maharashtra. The total area covered under oats cultivation in the country is about 5 lakh ha. The crop occupies maximum area in Uttar Pradesh (34 per cent), followed by Punjab (20 per cent), Bihar (16 per cent), Haryana (9 per cent) and Madhya Pradesh (6 per cent) (Pandey and Roy, 2011). It provide forage in early season when no other green fodder is available and can be accommodated easily under double cropping system immediately after over of *Kharif* season. However, one of the important constraints in its cultivation is the infestation of the crop to a large number of insect pests at different stages of crop growth. Aphid (Homoptera: Aphididae) are serious sucking insect pest, problem in many cereal-

growing regions of the world, and they pierce and suck sap from leaves, stems, and less frequently the developing kernels and infect plants with harmful viruses. Phloem sap only contains small amounts of the amino acids that the aphids need, so they must consume large volumes of it, meaning that they subsequently have to excrete excess liquids and sugars. If population densities are high, this excretion can create a sticky film on plant surfaces that can reduce photosynthesis and promote the growth of sooty mold (Blackman and Eastop, 2000). The population of *Rhopalosiphum padi* (Linnaeus) was the most abundant and it was the most important aphid species on oat whose occurrence interfered with grain formation and grain filling (Kannan, 1997). Most of them because of parthenogenesis, viviparous 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). Oat is generally grown in India for fodder purposes and aphids can cause 35-40% loss directly by sucking sap and 20-80% indirectly by transmission of fungal and viral diseases (Rossing *et al.,* 1994). Several methods have been practiced for the management of aphids. These includes: cultural, physical, mechanical, biological, chemical and host plant resistance. Management of oat aphids has been done primarily by using chemical methods; however environmental and health problems have arisen due to this practice. Indiscriminate use of insecure synthetic chemical pesticides and demanding crop production causes several socio-economic problems throughout the world. For example, more than twenty aphid species together with *Myzus persicae* (Harrington and Emden, 2007) have showed resistance to a number of carbamate, pyrethroid and organophosphate insecticides. Therefore, non chemical management is most important to avoid residual toxicity of chemical pesticide.

Entomopathogenic fungi provide an environmental responsive substitute to chemical pesticides. They are natural, easy to formulate, less toxic to mammals, with no residual activity (Copping, 2004) and less chance to develop resistance (Zimmermann, 2007). Up till now, a variety of strains of entomopathogenic fungi such as *Lecanicillium lecanii*, *Beauveria bassiana* and *Metarrhizium anisopliae* (Devi *et al*., 2003) have been used for the management of aphids and many other pests. Botanicals like econeem, neem seed extract were moderately effective against aphids. (Salunkhe, 2003).

The increasing concern for the environment, development of insect resistance to insecticides and the emerging trend towards organic farming have driven the search for effective and eco-friendly alternatives. In this context, the present investigations were undertaken.

MATERIALS AND METHODS

Experimental site

The present investigation entitled, efficacy of microbial and botanical pesticides against oat aphid (*Rhopalosiphum padi* L.) was carried out during *Rabi* season of 2016-17 to 2019-20 under field condition at the All India Coordinated Research Project on Forage Crops & Utilization at MPKV, Rahuri Dist-Ahmednagar, Maharashtra.

Soil

The topography of the field was fairly uniform and leveled. The soil of experiment area was medium black with adequate drainage.

Climatic Conditions

Geographically, the central campus of Mahatma Phule Krishi Vidyapeeth is situated between $19^0$47' and $19^0$57' North latitude and between $74^0$32' and $74^0$19' East longitude. The altitude varies from 495 to 569 meters above the sea level. Climatically, this area falls in semi-arid tropics with annual rainfall varying from 307 to 619 mm. An experiment was conducted during Rabi season of 2016-17, 2018-19 and 2019-2020 of the months October to May at All India Coordinated Research Project on Forage Crops & Utilization at MPKV, Rahuri Dist- Ahmednagar, Maharashtra. Meteorological Observatory is graphically depicted in Fig. 1 showing climatic condition during the period of present investigation.

During year 2016-17, 2018-19 and 2019-2020 the maximum temperature was ranged between 41.13-28.8, 41.2- 26.5 and 40.1- 23.5 ^{0}C, minimum temperature was ranged between 8.8-23.6, 8.8-24.0 and 11.9-26.10, morning relative humidity was 31-36, 32-67 and 55-87, evening relative humidity was 11-59, 12-46 and 17-79 and total rainfall was 2.8, 6.4 and 263.8 respectively (Fig. 1.).

Experimental details

Oat variety Kent was sown with

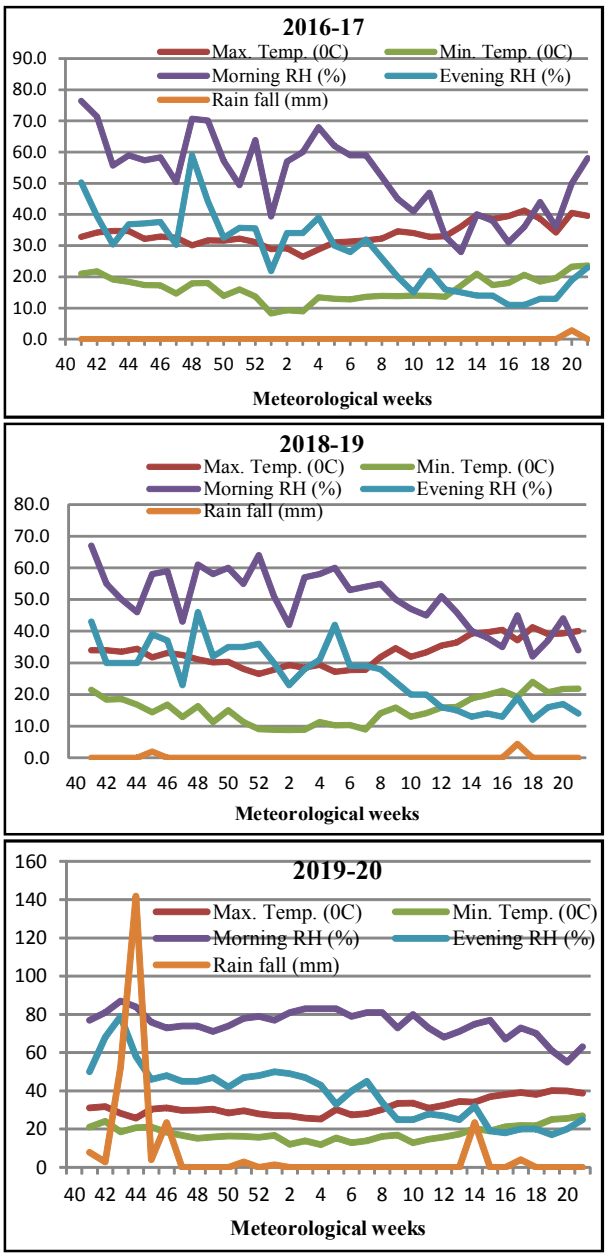

Fig. 1. Meteorological data recorded during the experimental period.

recommended agronomic practices in at 25 cm spacing as line sowing in 3 × 4 m plot size with. For the aphid management, a trial was laid out in the randomized block design with three replications and each replication has five rows. Variety "Kent" was used and two biopesticides of different concentrations and one botanical pesticide of two different formulations were tested (Table 1). The crop was harvested for taking green fodder after 55-60 days of sowing.

Observation recorded

Observations on the aphid population from the selected plants were recorded before and after 5 and 7 days of spray. From experimental plot randomly ten tillers of oat were selected for recording the observation on aphid and natural enemies observation were counted at early morning from five leaves each from top, middle and bottom and their average was taken. Average population per tiller was calculated separately for aphid and their natural enemies.

Green Forage Yield

Harvesting was done at 60 days after sowing. The treatment wise total green forage yield was recorded kg/plot and converted it into q/ha.

Data 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=0.5. The percentage data subjected to population as square root transformation whenever needed.

Biopesticides

The biopesticides were obtained from the Biocontrol unit, Department of Agricultural Entomology, MPKV, Rahuri Dist. Ahmednagar (M.S) While, botanical pesticide was purchased from the market.

RESULTS AND DISCUSSION

The pooled data for consecutive three years (2016-17 to 2019-20) pertaining to effect of various biological (entomopathogenic fungal biopesticides) and crude extract of plant products on aphids control in oat is presented in Table 2. The pooled data revealed that at 5 days after spray all the biopesticides were found superior in suppressing the aphid population as compared to untreated control, among all the treatments, foliar application of *L. lecanii* 1.5% WP *@7.5* gm/lit was statistically found to be the most effective treatment in controlling aphids, it was recorded significantly lower (30.04 aphids/ tiller) number of aphids as compared to other treatments. The next performing treatments in order to their merits were *Metarhizium anisopliae* 1.15% WP @ 7.5 g/L, Neem seed extract 5% , *Lecanicillium lecanii* 1.15% WP @ 5 g/L, Azadirachtin 10000 ppm, *Metarhizium*

TABLE 1
Details of biopesticides and botanicals

S. No.	Particulars	Formulation	Dose g/lit	Trade name	Manufacturer or source
1.	*Lecanicillium lecanii* 1.15% WP	Wettable powder 1×10^8 cfu/gm	5.0 g & 7.5 g	Phule Bugicide	Biocontrol unit, Dept. of Agril. Entomology, MPKV, Rahuri
2.	*Metarhizium anisopliae* 1.15% WP	Wettable powder 1×10^8 cfu/gm	5.0 g & 7.5 g	Phule Metarhizium	
3.	Azadirachtin 10,000 ppm	Emusifiable Concentrates	3 ml	Nimbecidine	T- Stanes & companies limited, Coimbatore
4.	Neem Seed extract 5% (NSE)	5% NSE	5 ml	-	Locally prepared

anisopliae 1.15% WP @ 5 g/L which were recorded 31.26, 33.26, 33.50, 34.28, and 36.40 aphids per tiller, respectively.

The results in respect of survival of aphid population at 7 days after spraying revealed that the similar trend of the result was obtained as resulted in 5 DAS. The treatment with L. *lecanii* @7.5gm/lit recorded significantly lower number of aphid (8.77 aphids/tiller), which proved to be significantly superior over other biopesticides. However, it was at par with *Metarhizium anisopliae* 1.15% WP @ 7.5 g/L (10.49 aphids/tiller) and *L. lecanii* @ 5 gm/lit (10.54 aphids/tiller). Performance of the remaining treatments in order to their merits were *M. anisopliae* @ 5 gm/lit, neem seed extracts 5% and Azadirachtin 10000 ppm @ 2 ml/lit. These treatments were recorded 13.75, 19.11 and 20.94 aphids per tiller, respectively. The data on population of natural enemies was non-significant at 5 and 7 days after spray, means biopesticides did not affect the activities of coccinellid predators. In the present context of efficacy of microbial and botanical biopesticides for aphid the *Lecanicillium lecanii* 1.15% WP @ 7.5 g/L, *Metarhizium anisopliae* 1.15% WP @ 7.5 g/L.

All the entomopathogenic fungi showed the pathogenic effect on aphids at 5 and 7 days after treatment and it maintained later on due to epizootic nature. Among entomopathogenic fungi *Lecanicillium*

TABLE 2
Effect of biopesticides and botanicals on survival population of oat aphids, ladybird beetle (Average of Two sprays) and green forage yield (Pooled analysis of year 2016-17, 2018-19 and 2019-20

S. No.	Treatments	Dose (%)	Pre count	Av. No. of aphids/tiller		Av. No. of LBB grubs/tiller			GFY (q/ha)
				5 DAS	7 DAS	Pre count	5 DAS	7 DAS	
1.	Lecanicillium lecanii 1.5 % WP	5 gm/lit.	48.72 (7.02)	30.04 (5.53)	10.20 (3.27)	1.87 (1.54)	2.60 (1.76)	2.80 (1.82)	577.59
2.	Lecanicillium lecanii 1.5 % WP	7.5 gm/lit.	49.99 (7.11)	26.59 (5.20)	8.76 (3.04)	1.78 (1.51)	2.61 (1.76)	2.82 (1.82)	583.17
3.	Metarrhizium anisopliae 1.5 % WP	5 gm/lit.	48.32 (6.99)	33.063 (5.79)	13.91 (3.80)	1.87 (1.54)	2.69 (1.79)	2.85 (1.83)	575.92
4.	Metarrhizium anisopliae 1.5 % WP	7.5 gm/lit.	48.51 (7.00)	27.59 (5.30)	10.17 (3.27)	1.96 (1.57)	2.72 (1.80)	2.73 (1.80)	577.76
5.	Azadirachtin 10,000 ppm	2 ml/lit	49.57 (7.08)	31.16 (5.63)	20.87 (4.62)	1.96 (1.57)	2.71 (1.79)	2.69 (1.79)	555.51
6.	Neem Seed extract (NSE)	5 %	50.25 (7.12)	29.92 (5.52)	18.68 (4.38)	1.78 (1.51)	2.74 (1.80)	2.72 (1.79)	558.19
7.	Untreated control	-	49.46 (7.07)	54.80 (7.44)	62.24 (7.92)	2.04 (1.60)	2.69 (1.79)	2.82 (1.82)	502.66
	SE ±	-	0.14	0.27	0.12	0.06	0.03	0.03	4.55
	CD at 5%	-	NS	0.84	0.38	NS	NS	NS	14.01
	CV%		3.47	7.68	7.94	6.38	3.23	2.85	11.40

*Figures in parenthensis indicating n+0.5 DAS- Days After Spray, GFY- Green Forage Yield, LBB- Lady Bird Beetle.

lecanii 1.15% WP @ 7.5 g/L, was found to be the most effective in reducing the aphid population and registering the maximum yield. These findings are in supportive with Kazda (1994) reported that *L. lecanii* causes 60% mortality in aphids. Similarly, Deng *et al.* (1991) recorded that *L. lecanii* causes 30 to 50 percent mortality in aphids. All the biopesticides specially, entomopathogenic fungi showed significant control of aphid population as compare to untreated control (Anon, 2014). The result in respect on bioefficacy of *Lecanicillium lecanii* and *Metarhizium anisopliae* found in conformity with those reported by Patil *et al.* (2015) and Walkunde *et. al*. (2019) who observed 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 inconformities with present finding were also reported by Ghortale (2015). The effectiveness of biopesticides against oat aphid is supported by the findings of Jung *et al.* (2006) and Kim (2004) by *lecanicillium sp*, Shia and Feng (2004) and Wright *et al*. (2004) by *M. anisopliae B. bassiana* (Quesada-Moraga *et al*., 2006), and *Nomuraea rileyi* (Devi *et al*., 2003) have been used for the management of aphids and many other pests.

Neem based insecticides proved to be their moderate effectiveness against aphids upto 7 days after spray treatment during present investigation. Gour and Pareek (2003) reported that NSE as least effective against mustard aphids on mustard. Salunkhe (2003) reported moderate effect of econeem and neem seed extract on cowpea aphids on cowpea. Verma and Chaman Lal (2006) reported that *Azadirachta indica* was effective statistically but provided only moderate level of control of mustard aphids.

All the biopesticides were found safer to predatory lady bird beetles as they showed near about equal population of lady bird beetle grubs per plant at 5 and 7 days after foliar sprays as it was observed in untreated plot. There was no significant difference among the treatments in respect of lady bird beetle count. Similar, results were reported by, Haseeb and Murad (1997), Tambe (2009), Gangawane (2017).

CONCLUSION

Among the entomopathogenic fungal treatments, *L. lecanii* 1.5% WP (7.5 g/L) gave effective aphid control with highest green forage yield of oat. Whereas, *M. anisopliae* 1.5% WP (7.5 g/L), *L. lecanii* 1.5% WP (5 g/L), *M. anisopliae* 1.5% WP (5 g/L) were next alternative treatments for management of oat aphids. Neem based insecticide were found moderately effective against aphid. All the entomopathogenic fungal, neem based treatments were found safe to coccinellid, not any treatment showed pathogenic effect on predatory coccinellids at 5 and 7 days after application. Overall results indicated that all entomopathogenic fungi showed their pathogenicity on oat aphids due to the thick plant population of oat, it maintained micro climate which help to fungi for fast multiplication on target pests. Forage oat is green forage crop which is highly nutritious as animal feed. It is therefore, necessary to avoid chemical pesticides which can be harm to animal and human being through milk/meat consumption also. Entomopathogenic fungi are the most important solution to avoid toxicity of chemical insecticides and safer to natural enemies for their survival. Incorporation of entomopathogenic fungus *viz., L. lecanii* and *M. anisopilae* in IPM programme would be effective and ecofriendly management of oat aphid.

ACKNOWLEDGEMENT

Authors are thankful to Project coordinator and Principal Investigator (Crop Protection) AICRP on Forage Crops and Utilization, Jhansi for their time to time support. This research work was funded under AICRP on Forage Crops and Utilization, Jhansi and support providing for field experiments by Forage Crop Research Project, MPKC, Rahuri is also acknowledged.

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