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Comparative Efficacy of Bio Active Plant Extracts and Insecticides against Cereal Leaf Beetle (*Oulema melanopus* L.) Infesting Oats in North Kashmir, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Experiment was carried out at farmers field near the Faculty of Agriculture, Wadura, Kashmir, India during 2021-22 to evaluate efficacy of various insecticides and botanicals against cereal leaf beetle *Oulema melanopus* (L.) (Coleoptera: Chrysomelidae) infesting *Rabi* Oats (*Avena sativa* L.) in North Kashmir. Among plant extracts and insecticides evaluated against *O. melanopus*, Abamectin proved to be most effective in causing huge mortality to grub population with decreasing number of

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grub were recorded as (24, 21.3, 8.3, 1.6 and 1 %) after 2,4,6,8 and 10 days of spray, respectively during 2021 followed by Thiamethoxam (32.6, 15.3, 8, 0.3%) after 2, 4, 6, 8 ad 10 days of spray. Same trend of results was observed in 2022 and the pooled data. Among tested botanicals *viz.* neem and *Artimesia; Artimesia* was effective in declining the grub population with (44, 42, 41, 39 and 37%) after 2, 4, 6,8 and 10 days after spray. Severe infestation has been observed at maturity of crop and keeping in view the use as fodder to cattle it is necessary to inculcate the use of locally available botanicals for better health of cattle during the dearth period of fodder in Kashmir valley. Overall, the marginal farmers might be saved from any untoward by utilization of the bioactive plant extracts in management of this notorious pest.

Keywords: Oats; oulema melanopus; mortality; plant extract; notorious pest; avena sativa; sorghum; cosmetic industry.

1. INTRODUCTION

The oats, *Avena sativa* Linnaeus occupies the 6th place among main crops, cultivated throughout the world after wheat, maize, rice, barley and sorghum [1]. The main purpose of its cultivation is to obtain source of food for livestock and also for seed because it is known to be nutritionally and medicinally valuable [2]. The grain is now mostly preferred to use because of its rich source of nutrients and beneficial for health [3]. The oats also occupy important place in the biochemical and cosmetic industry (Tiwari and Cummins, 2009). Oats is being used as an important grain crop especially by the people of peripheral populations among the developing countries, and for specifically important uses in developed world [4]. Oats are grown as a source of grain as well as for source of food for livestock, straw for bedding, hay, haylage, silage and chaff in many parts of the world [2].

Oats are rated as rich source of protein, dietary soluble fibers and minerals (Esposito et al., 2015). The oats are believed to contain protein content, equivalent to meat, milk and, egg protein. As food source oats are being most preferably used in breakfast, however it is being considered by consumers as healthiest food from natural source which adds to its global demand. Moreover, oats are preferred over other types of grain because it possess a distinctive nutritional composition and multifunctional benefits of select bioactive compounds, including protein, unsaturated fatty acids, soluble(beta-glucan) and insoluble fibre, micronutrients such as iron, potassium, copper and magnesium, thiamine, folate, zinc and phosphorus [5]. Oats is also provided with source of many compounds such as tocopherol, inositol hexaphosphate, phenolic compounds, avenanthramides and sterols that bears antioxidant activity [6]. Oats being rich in dietary fibers believed to produce various health benefits with preferably recommended to exhibit hypocholesterolemic and anticancerous properties [7,8]. In addition to above mentioned properties, it is known to be effective against a number of diseases prevailing in mankind [9].

The total world production of oats was reported to be 25.13 million metric tonnes with Russia the leading producer. (Shahbandeh M. 2024). In India, the total fodder cultivation constitutes approximately 4.9%, which covers an area of approximately 8.6 million ha on individual crop basis [10]. Whereas, oat cultivation occupies approximately about 1.0 million ha in the country with its production of 35-50 t/h [10]. In India, it is cultivated in Punjab, Haryana, Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra and West Bengal. Uttar Pradesh holds maximum share of oat production with - 34 per cent, followed by Punjab - 20 per cent, Bihar -16 per cent, Haryana - 9 per cent and Madhya Pradesh - 6 per cent [1].

Besides diseases, a number of insect pests has been reported so far on oats which lead to considerable losses in green fodder and oat meal as well (add reference). Fifteen (15) insect pests, belonging to 5 different orders were recorded in the oats (*Avena sativa* L.) Kashmir agro-ecosystem (add reference). Soil borne insects *viz.* white grubs (*Holotrichia longipennis*, *Brahmina* spp, *Melolontha furcicauda* and *Oryctes* spp), wireworm (*Agriotes* spp) and cutworm (*Agrotis* spp); sucking pests including wheat aphid (*Schizaphis graminum*), green stink bug (*Carpocoris* spp), aster leafhoppers (*Macrosteles quadrillineatus*), broad-headed bug (*Camptopus lateralis*) and oat thrips (*Stenothrips graminum*) and foliage pests including cereal leaf beetle (*Oulema melanopus* L.), surface grasshopper (*Chrotogonus trachypterus* Blanchard), armyworm (*Mythimna separata*) and gram pod borer (*Helicoverpa armigera*) appeared as pests in the oats field [11]. Among these *M.*

separata, *O. melanopus* and *H. armigera* were major pests [12]. The initial appearance of cereal leaf beetle was recorded in Southern Michigan of the United States in the beginning of 1960s but now have occupied major area of North America. This beetle is characterized to produce one generation in a year. Preferred overwintering sites include edges of crops and woodlots, fence rows, sparse woods and dense woods [13]. Within these sites, the beetles prefer field debris, crevices of bark and rolled leaves for overwintering [14,15]. Greater numbers of overwintering O. melanopus adults near 9 edges of stubble fields have also been reported in some instances [16]. Adults perform mating once the temperature reaches optimum levels of above 9-10 degrees Celsius (or 44.6 degrees F) and females have a comparably long laying period of approximately 45-60 days. Mating takes place on plants and eggs are laid along the leaf margins or close to the midrib [14]. Eggs are laid preferentially on central upper leaf surfaces on barley and wheat and on the central to basal region on oat [17]. The larvae make appearance in 7-15 days, and begin feeding on leaves with marked stripes along the leaf. The larvae took 12-20 days to attain maturity. Larvae poses serious threat to crops, as they consume upper surface of the leaves and make them hindered and unable to photosynthesize. Larvae are active from May until July. Larvae are less mobile and do not usually move from one plant to another. Pupation occurs beneath the soil in July and teneral adults emerge in about three weeks. keeping in view the above facts it becomes imperative to study the "Seasonal Incidence of *Oulema melanopus* Infesting Rabi Oats (*Avena sativa* L.) in North Kashmir".

2. MATERIALS AND METHODS

An experiment was carried out to assess the efficacy of different insecticides and botanicals against the *Oulema melanopus* on oat crop at farmers field near Faculty of Agriculture, Wadura, SKUAST- Kashmir during 2021-22. Variety "*Sabzar"* was sown on 46th standard week of 2020 for this purpose. The experiment was laid out in a Randomized Complete Block Design with seven treatments and three replications, in a field measuring plot size was (3x4) m² (Total=24 plot) and spacing 22.5cm.

2.1 Green Leaf Extraction of *Artemisia annuna*

Leaves of *Artemisia annuna* were collected, washed with water to remove dirt and chopped into small pieces, then grinded using clean water in the ratio of 50 gm plant material in one litre of water to get 5% solution.

The treatments were imposed using a Knapsack sprayer. The death of larval population per m^2 was

recorded after spray at 2, 4, 6, 8, and 10 days after treatment. Per cent mortality of larvae over negative control was calculated. Data obtained from the experiments have been analyzed using standard statistical procedures. Insecticides and botanicals were applied in the evening to escape the effect of sunlight on chemicals.

Per cent mortality was calculated as:

$$Per\ cent\ mortality = \frac{Pre\ \ treatment\ count - Post\ treatment\ count}{Post\ treatment\ count} \times 100$$

Whereas,

Pre treatment count = Number of live larvae before treatments

Post treatment count = Number of live larvae after treatment

Similarly, increase mortality over control was calculated as:

$$\%\ Increase\ over\ control = \frac{Treated\ -\ control}{Treated} \times 100$$

3. RESULTS AND DISCUSSION

Field efficacy of different plant extracts and insecticides was evaluated against *O. melanopus* infesting oats under field conditions during 2021 and 2022. During 2021 it was evident from the data that among different insecticides evaluated after two days of spray, Abamectin 1.8EC was found effective (24%) in managing this pest population. Abamectin was followed by Chlorpyriphos20EC (30.6%) and Dimethoate 30EC (32%). After 4 days of spray Thiamethoxam 25 WG proved to be most effective in managing *O. melanopus* by (15.3%) followed by Abamectin 1.8 EC (21.3%). After 6 days of spray Thiamethoxam 25 WG significantly proved to be most effective with (8.0%) in rapid declining the pest population with closely followed by Abamectin 1.8EC (8.3%). After 8 days of spray both Thiamethoxam 25 WG and Abamectin 1.8EC resulted equally effective against pest population with (1.6%) followed by Chlorpyriphos 20EC with (4.6%). After 10 days of

spray Thiamethoxam 25 WG dominate the efficacy level with (0.3%) followed by Abamectin 1.8EC with (1.3%).

However, among the bioactive plant extracts evaluated against *O. melanopus* infesting oats, Artemisia GLE @5% was found most effective in overall mean per cent efficiency in causing mortality with (30.42%, 31.61%, 32.80%, 35.19% and 37.57%) after 2, 4, 6, 8 and 10 days of spray followed by Neem oil @5%.

During 2022 it is evident from the studies that among different insecticides evaluated after 2 days of spray, Abamectin 1.8EC was significantly found effective (25.3%) in managing this pest population. Abamectin was followed by Chlorpyriphos20EC (30.6) and Thiamethoxam 25 WG (32.3%). After 4 days of spray Thiamethoxam 25 WG proved to be most effective in managing *O. melanopus* by (14.3%) followed by Abamectin 1.8 EC (22.0%). After 6 days of spray Thiamethoxam 25 WG significantly proved to be most effective with (8.0%) in rapid declining the pest population with closely followed by Abamectin 1.8EC (8.3%). After 8 days of spray both Thiamethoxam 25 WG and Abamectin 1.8EC resulted equally effective against pest population with (1.6%) followed by Chlorpyriphos 20EC with (3.6%). After 10 days of spray Thiamethoxam 25 WG dominate the efficacy level with (0.3%) followed by Abamectin 1.8EC with (0.6%).

Among the botanicals evaluated against *O. melanopus* infesting oats, Artemisia GLE @5% was found most effective with (34.59%, 39.99%, 41.15%, 43.47 and 45.78%) after 2, 4,6,8 and 10 days of spray followed closely by Neem oil @5%.

In pooled data of 2021 and 2022 Abamectin 1.8EC proved most effective (24.6, 21.6, 8.3, 1.6 and 1 %) after 2, 4, 6, 8 and 10 days after spray, respectively. It was followed by Thiamethoxam 25WG by (32.5, 14.8, 8, 1.6 and 1%) after 2, 4, 6, 8 and 10 days after spray, respectively.

Among two botanicals tested *Artemisia* was found more effective with (44.83, 42.00, 41.00, 39.00, 37.00%) after 2, 4, 6, 8 and 10 days of spray respectively. Although, Laznik *et al*. (2010) described the activity of entomopathogenic nematodes (*Rhabditida*) against cereal leaf beetle (*O. melanopus* [L.], Coleoptera, Chrysomelidae). In this course of study, the three Slovenian strains of entomopathogenic nematodes) and commercial product Entonem (active ingredient of *S. feltiae*), were brought in use to measure their activity against cereal leaf beetle. The most effective strain and good alternative to chemical insecticides with greater tendency to control overwintered cereal leaf beetles was *S. carpocapsae* C101. The efficiency of entomopathogenic nematode was found greatly dependent on temperature. Similarly**,** Skuhrovec *et al*. [18] tested the efficiency of plant-derived essential oils and their encapsulations for protection of wheat from adults and larvae of cereal leaf beetle, *O. melanopus*. The two formulations extracted from plants were *Rosmarinus officinalis* with *Cymbopogon citratus* and *Pelargonium graveolens* with *Thymus vulgaris*. These two formulations of essential oil and encapsulation showed 100 per cent mortality within 24 hrs.

Furthermore, flag leaf defoliation causes more damage than does injury to lower leaves. These results are consistent with current knowledge of wheat physiology that the 3-wk period before anthesis is the most critical phase for determining grain yield, in the form of number of seeds per acre [19]. Cereal leaf beetle eggs hatch over an extended period, which once led to recommendations to wait until most of the cereal leaf beetle eggs had hatched before applying an insecticide [20,21]. However, considerable defoliation can occur before most of the eggs have hatched [22,23]. Detailed studies in Virginia and North Carolina show a close relationship between egg populations and number of fourth-stage larvae per stem [22]. Phosphate insecticides generally were not effective when applied before most eggs had hatched. Lambda Cyhalothrin provides the option of using a threshold based on cereal leaf beetle eggs per stem, and applying the insecticide early before or near 50% egg hatch [24]

3.1 Percentage of Grub Mortality by Different Insecticides and Plant Bio Extracts

Comparative efficacy of different plant extracts and chemical insecticides was evaluated to assess the mortality of *Oulema melanopus* grub infesting oats under field conditions during 2021 and 2022. During 2021 it was evident from the data that among different insecticides evaluated after two days of spray, Abamectin 1.8EC was found effective and caused (54.52%) mortality. Abamectin was followed by Chlorpyriphos20EC resulted in causing mortality upto (48.92%), Thiamethoxam 25 WG with (45.11%). After 4 days of spray Thiamethoxam 25 WG proved to be most effective in causing huge mortality of

Table 1. Efficacy of various botanicals and insecticides against cereal leaf beetle (*Oulema melanopus*)

Treatment	Pre-count		2DAS			4DAS			6DAS			8DAS			10DAS		
	Year																
	2021	2022	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Chlorpyriphos 20EC @ 0.02%	85.00	88.66	30.66 (33.60)	30.66 (33.61)	30.66	21.66 (27.72)	22.33 (28.18)	22.00	9.33 (17.77)	9.66 (18.10)	9.50	4.66 (12.45)	3.66 (11.01)	4.16	2.00 (7.94)	1.66 (7.33)	1.83
Dimethoate 30EC @ 0.03%	82.66	85.33	32.00 (34.43)	33.66 (35.45)	32.83	24.66 (29.75)	25.00 (29.98)	24.83	17.00 (24.33)	17.33 (24.59)	17.16	5.00 (12.87)	5.00= (12.87)	5.00	2.33 (8.74)	2.00 (7.94)	2.16
Thiamethoxam 25WG @ 0.01%	84.00	87.00	32.66 (34.84)	32.33 (34.64)	32.50	15.33 (23.02)	14.33 (22.23)	14.83	8.00 (16.40)	8.00 (16.40)	8.00	1.66 (7.33)	1.66 (7.33)	1.66	0.33 (1.91)	0.33 (1.91)	0.33
Abamectin 1.8EC @0.09%	83.33	86.00	24.00 (29.31)	25.33 (30.20)	24.66	21.33 (27.48)	22.00 (27.95)	21.66	8.33 (16.76)	8.33 (16.76)	8.33	1.66 (7.33)	1.66 (7.33)	1.66	1.33 (6.53)	0.66 (3.82)	1.00
Artemisia GLE @ 5%	84.00	86.33	45.00 (42.11)	44.66 (41.92)	44.83	44.00 (41.53)	40.00 (39.21)	42.00	43.00 (40.95)	39.00 (38.62)	41.00	41.00 (39.79)	37.00 (37.44)	39.00	39.00 (38.62)	35.00 (36.25)	37.00
Neem oil @ 5%	84.66	86.00	47.33 (43.45)	46.33 (42.88)	46.83	45.66 (42.49)	40.33 (39.40)	42.99	45.33 (42.30)	38.66 (38.41)	41.99	43.00 (40.95)	37.00 (37.44)	40.00	40.00 (39.21)	36.00 (36.85)	38.00
Control	84.33	87.66	83.33 (65.93)	82.66 (65.39)	83.00	80.00 (63.42)	80.00 (63.41)	80.00	76.33 (60.87)	76.00 (60.64)	76.16	73.66 (59.10)	74.66 (59.75)	74.16	67.66 (55.33)	68.33 (55.73)	68.00
C.D.	N/A	N/A	2.03	1.71		2.15	1.66		1.67	2.04		2.37	2.24		3.37	3.62	
SE(m)	1.09	1.63	0.65	0.55		0.69	0.53		0.53	0.65		0.76	0.72		1.08	1.16	
C.V.	2.86	4.28	2.78	2.35		3.27	2.59		2.96	3.71		5.13	5.04		8.28	9.40	

DAS: Days After Spray

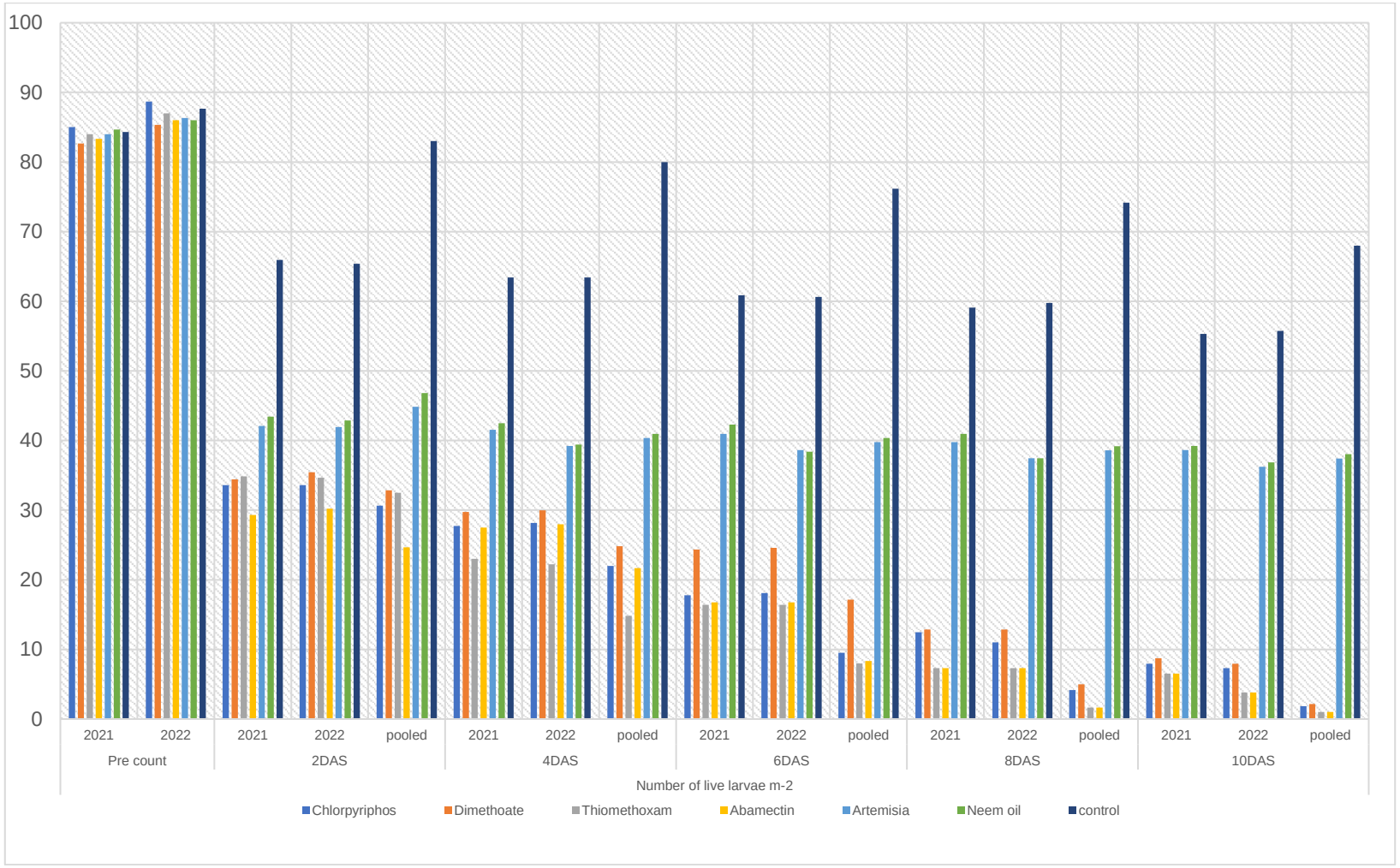

Fig. 1. Efficacy of various botanicals and insecticides against cereal leaf beetle, *Oulema melanopus*

Table 2. Percentage of grub mortality count

Treatment	2DAS		4DAS		6DAS		8DAS		10DAS	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Chlorpyriphos 20EC @ 0.02%	48.92	54.07	59.51	63.47	74.02	77.76	79.51	84.53	82.64	86.78
Dimethoate 30EC @ 0.03%	43.94	45.88	52.82	56.03	62.09	65.02	76.61	79.47	79.84	82.98
Thiamethoxam 25WG @ 0.01%	45.11	49.83	65.75	70.52	74.47	77.80	82.02	85.09	83.60	86.62
Abamectin 1.8EC @0.09%	54.52	56.64	57.73	60.41	73.33	76.31	81.33	84.06	81.73	85.23
Artemisia GLE @ 5%	30.42	34.59	31.61	39.99	32.80	41.15	35.19	43.47	37.57	45.78
Neem oil @ 5%	28.75	32.12	30.72	39.10	31.11	41.04	33.86	42.97	37.41	44.13

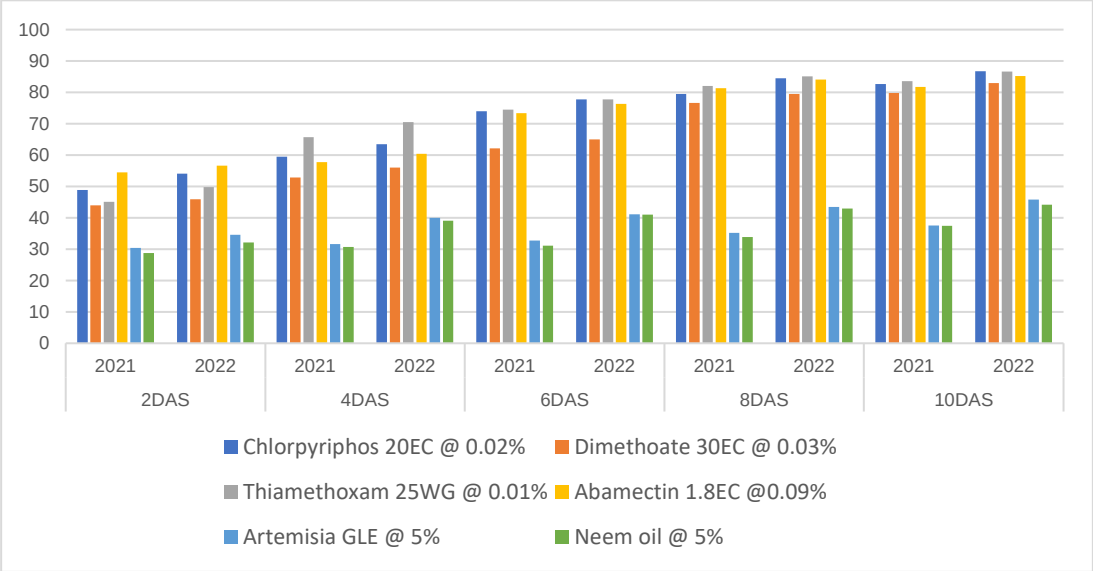

Fig. 2. Percentage of grub mortality count

O. melanopus larvae by (65.75%) followed by Chlorpyriphos 20EC (59.51%). After 6 days of spray Thiamethoxam 25 WG significantly proved to be most effective with (74.47%) in rapid mortality of the pest population with closely followed by Chlorpyriphos 20EC (74.02%). After 8 days of spray Thiamethoxam 25 WG showed (82.02%) mortality followed by Abamectin 1.8EC with (81.33%) mortality. After 10 days of spray Thiamethoxam 25 WG dominate the efficacy level with (83.60%) followed by Chlorpyriphos 20EC with (82.64%).

However, among the bioactive plant extracts evaluated against *O. melanopus* infesting oats, Artemisia GLE @5% was found most effective in overall mean per cent efficiency in causing mortality with (30.42%, 31.61%, 32.80%, 35.19% and 37.57%) after 2, 4, 6, 8 and 10 days of spray followed by Neem oil @5% as mentioned in the Table 2.

During 2022 it is evident from the studies that among different insecticides evaluated after 2 days of spray, Abamectin 1.8EC was significantly found effective in causing (56.61%) mortality. Abamectin was followed by Chlorpyriphos20EC (54.07%) and Thiamethoxam 25 WG (49.08%). After 4 days of spray Thiamethoxam 25 WG proved to be most effective in causing most mortality of *O. melanopus* by (70.52%) followed by Chlorpyriphos20EC (63.47%). After 6 days of spray Thiamethoxam 25 WG significantly proved to be most effective with (77.80%) mortality with closely followed by Chlorpyriphos20EC (77.76%). After 8 days of spray Thiamethoxam 25 WG resulted effective with (85.09%) mortality followed by Chlorpyriphos 20EC with (84.53%). After 10 days of spray Chlorpyriphos20EC dominate the efficacy level with (86.78%) with closely followed by Thiamethoxam 25 WG with (0.6%) larval mortality.

Among the botanicals evaluated against *O. melanopus* infesting oats, Artemisia GLE @5% was found most effective with (34.59%, 39.99%, 41.15%, 43.47 and 45.78%) after 2, 4,6,8 and 10 days of spray followed closely by Neem oil @5% as mentioned in the Table 2.

4. CONCLUSION

In reference to field efficacy of different plant extracts and insecticides evaluated against *O. melanopus* Abamectin proved to be most effective (24, 21.3, 8.3, 1.6 and 1 %) after 2.4.6.8 and 10 days of spray, respectively during 2021 followed by Thiamethoxam (32.6, 15.3, 8, 0.3%) after 2, 4, 6, 8 ad 10 days of spray. Same trend of results was observed in 2022 and the pooled data.

Among two tested botanicals *viz.* neem and *Artimesia, Artimesia* was effective with (44.83%, 42.00%, 41.00%, 39.00% and 37.00%) after 2, 4, 6,8 and 10 days after spray in managing the pest.

Infestation of cereal leaf beetle has been at alarm in the area, hence keen attention is to be

taken to devise best possible management strategy. Local botanical *Artimesia* along with other organic approaches can be utilized in formulating the integrated pest management programme to get rid of cereal leaf beetle for boosting the farmers income, minimizing environmental hazards especially for the cattle whom oats act as a feed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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