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Diversity of arthropods in an organically cultivated mustard ecosystem

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ABSTRACT

During the experiment, fifty- nine different arthropods were recorded belonging to twelve different orders. The arthropods were categorized considering the role of induvial arthropod in the crop ecosystem. The insect pest recorded includes mustard aphid, *Lipaphis erysimi*, Mustard Sawfly, *Athalia sp.*, Diamondback moth, *Plutella xylostella*, *etc.* The helpful activities of twenty-two arthropods were also noticed. Among them, different species of honey bees were dominating pollinators and *Coccinella transversalis* and *Cheilomenes sexmaculata* were major predators. The substantial parasitization of aphids by *Diaeretiella rapae* was also documented. Among the different orders of arthropods, Lepidoptera (27%) was the dominant order in terms of the number of species followed by Hymenoptera (20%) and Hemiptera (15 %).

Key words: *Arthropods, Mustard, Pest, Natural enemies, Mustard Aphid, Diaeretiella rapae*

Introduction

India is one of the leading mustard-growing countries in the world. In India, after groundnut, *Brassica juncea* is the second most important oilseed crop, accounting for about 30.7 per cent of the total oilseed production of the country (Yadav et al., 2018). The ecosystem of a crop is composed of many living organisms. This biotic component of the ecosystem is dominated by arthropods, which play different roles in the crop ecosystem. Mustard is also visited by many arthropods. Among them, more than 43 species have been reported to be insect pests like mustard aphids, mustard sawfly, painted bug, etc. damaging the crop from the early stages of crop growth till maturity and causing 10 to 90 % damage depending on location, the severity of the infestation, and the level of protection (Khan *et al*., 2013). Contrarily, many arthropods are beneficial for a crop and play important role in pest management, pollination, decomposition of organic matter, etc. (Culliney, 2013). The study also helps to assess the health of an ecosystem as richness of arthropods is one of the key indicators of a healthy ecosystem. The study of arthropods may also help us to predict future threats from invasive insects. Therefore, studies were carried out to record the diversity of arthropods in the mustard ecosystem.

Material Methodology

The experiment was carried out at the Experimental- cum demonstration farm, Maheshpur. Morabadi, Ranchi during the rabi season of 2020- 21 and 2021- 22. This experimental site is situated in the southern part of the Chhota Nagpur plateau of Jharkhand state. The experimental site is located at 23023'01" N latitude and 85020'13" E longitudeThe diversity of arthropods (insects and spiders) was recorded at weekly intervals from the crop fields, in

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which pest management strategies were not adopted from emergence to the harvesting of the crop. The surveillance was conducted using different methods and devices considering the habit and habitat of arthropods like visual observations of the crop, netting, and the use of different devices viz., Pitfall traps, light traps, yellow sticky traps, and pheromone traps. All the arthropods were identified and listed. The recorded insects were identified at the Entomology laboratory, RKMVERI, Ranchi based on morphological characteristics, published taxonomic keys, and related literature, and classified into different orders and families. The arthropods were also categorized as per their roles in the crop ecosystem. The relative abundance of arthropods was calculated and expressed in percentages.

Results and Discussion

The diversity of arthropods was recorded during both the seasons (2020-21 and 2021- 22) and their relative abundance is presented in table: 1,2 and 3. During the study, it was noticed that the crop was visited by 59 different species of arthropods. The recorded arthropods are categorised taxonomically (based on order) as well as based on their role in the mustard ecosystem. The diversity included 12 different orders of arthropods like Lepidoptera, Hymenoptera, Hemiptera, Coleoptera, Diptera, Odonata, Isoptera, Neuroptera, Orthoptera, Araneae, Dermaptera, Dictyoptera. The highest number of insects (per cent) was observed from order Lepidoptera (27%) followed by Hymenoptera (20%), Hemiptera (15%), Coleoptera (13%), Diptera (10%), Odonata (3%) and 2% each from Isoptera, Neuroptera, Orthoptera, Araneae, Dermaptera, Dictyoptera

The recorded arthropods were grouped based on their roles in the crop ecosystem and it is evident that the ecosystem was dominated by helpful arthropods (38%) followed by casual visitors (35%) and pest (27%).

The category of pests was also dominated by Lepidoptera (6 species) followed by Hemiptera (4 species), Diptera (2 species) and Coleoptera, Orthoptera, Hymenoptera, and Isoptera (single species). Among them, Mustard aphid, Mustard sawfly, Diamondback moth, Leaf miner, Cabbage butterfly, and Painted bug, were the major pests whereas, Beet leafhopper, Cabbage looper, Cabbage maggot, Green Stink Bug, Flea beetle, Gram pod borer, Leaf webber, Mole cricket, Termites, and Tobacco caterpillar were minor. The relative abundance of pests was highest during 2021-22 (53.85%) compared to 2020-21 (46.15%) (Table 1).

The present results are in conformity with Nayek *et al.*, 2022, Das, 2020, Patel *et al.*, 2019 that mustard aphids, cabbage butterfly, and diamondback moth

Table 1. List of pests recorded in the mustard ecosystem

Sl. No.	Common name Major Pest	Scientific name	Order	Family	2020-21	2021-22
1	Aphid	*Liphaphis erysimi* (K)	Hemiptera	Aphididae	+	+
2	Cabbage butterfly	*Pieris brassicae* (Linn)	Lepidoptera	Pieridae	+	+
3	Diamondback moth	*Plutella xylostella* (Linnaeus)	Lepidoptera	Plutellidae	+	+
4	Leaf miner	*Chromatomyia horticola* (Gorreau)	Diptera	Agromyzidae	+	+
5	Painted bug	*Bagrada hilaris* (Burm.)	Hemiptera	Pentatomidae		+
6	Sawfly	*Athalia sp.*	Hymenoptera	Tenthredinoidea	+	+
	Minor Pest					
7	Beet Leafhopper	*Circulifer Tenellus* (Baker)	Hemiptera	Cicadellidae	+	
8	Cabbage looper	*Trichoplusia ni* (HÜBNER)	Lepidoptera	Noctuidae	+	+
9	Cabbage maggot	*Delia radicum* (L.)	Diptera	Anthomyiidae		+
10	Flea beetle	*Phyllotreta crucifeae* (Goueau)	Coleoptera	Chrysomelidae	+	+
11	Gram pod borer	*Helicoverpa armigera* (Hub.)	Lepidoptera	Crambidae	+	+
12	Green Stink Bug	*Nezara viridula* L.	Hemiptera	Pentatomidae	+	
13	Leaf webber	*Crocidolomia binotalis* (zeller)	Lepidoptera	Pyralidae		+
14	Mole Cricket	*Gryllotalpa sp*	Orthoptera	Tettigonidae		+
15	Termites	*Odontotermus obesus* (Rambur)	Isoptera	Termitidae	+	+
16	Tobacco caterpillar	*Spodoptra litura*	Lepidoptera	Noctuidae	+	+
	Total				12	14
	Relative abundance (%)				**46.15**	**53.85**

are major and tobacco caterpillar, cabbage semilooper, green bug, flea beetle, leaf webber, are minor pests. It is also reported that mustard aphid is a nationally important insect-pest (Jana *et al.,* 2021). In another study, Mandal *et al.,* (2019) recorded 19 species of arthropods belonging to 19 different families from 7 orders in the mustard field without any pest management practices. The abundance of arthropod species varied with geographical location, season, host plant, and management practices of the crop. Roy *et al.,* 2016 reported that 29 insect species belonging to 16 families under 7 orders as visitors of *Brassica juncea*. Among the different orders, he has also reported the dominance of Lepidoptera in terms number of species followed by Coleoptera and Hymenoptera. In 2018, Bhat studied the pest species of cole crops in Jammu and Kashmir (J& K) and observed 16 lepidopterous pests in brassicaceous crop ecosystems among which, *Thysanoplusia orichalcea*, *Pieris brassica*e, *Pieris rapae*, *Plutella xylostella*, *Agrotis ipsilon* and *Helicoverpa armigera* were the major pests.

The deviation in abundance of arthropods was also noticed during the study and the deviation may be due to the unfavourable prevailing climatic conditions during 2020-21 as considerable decrease in temperature was noticed during the growing season. Similar effect due to unfavourable climatic conditions on abundance of arthropods is also reported by Sharif *et al.,* 2022.

During the study, different beneficial activities being carried out by arthropods were also noticed. Both the years, twenty- two helpful insect species. Among these insect species, 14 were predators, 4

Table 2. List of helpful arthropods recorded in the mustard ecosystem

Sl. No.	Common name	Scientific name	Order	Family	2020-21	2021-22
A. Predator						
1	Aphid lion	*Chrysoperla carnea* (Steph.)	Neuroptera	Chrysopidae	+	+
2	Common Earwig	*Forficula auricularia* L.	Dermaptera	Forficulidae		+
3	Ground Beetle	*Calleida decora* (Fabricius)	Coleoptera	Carabidae	+	+
4	Ladybird Beetle	*Harmonia axyridis* (Pallas)	Coleoptera	Coccinellidae	+	+
5	Ladybird beetle	*Coccinella transversalis*, Fabricus,	Coleoptera	Coccinellidae		+
6	Ladybird beetle	*Menochilus sexmaculatus* (Fabricius)	Coleoptera	Coccinellidae	+	+
7	Ladybird beetle	*Coccinella septempunctata*, Linnaeus	Coleoptera	Coccinellidae	+	+
8	Ladybird beetle	*Cheilomenes sexmaculata* (Fabricius)	Coleoptera	Coccinellidae	+	+
9	Milky dartlet	*Agriocnemis lacteola* Selys,	Odonata	Coenagrionidae	+	+
10	Praying mentids	*Mantis spp*	Dictyoptera	Mantidae	+	+
11	Rove Beetle	*Paederus Spp.*	Coleoptera	Staphylinidae	+	+
12	Spider	–	Aranae	–	+	+
13	Swampwatcher dragonfly	*Potamarcha congener* (Rambur)	Odonata	Libellulidae	+	+
14	Syrphid flies	*Syrphus sp.*	Diptera	Syrphidae	+	+
	Total				12	14
	Relative abundance (%)				46.16	53.84
B. Parasitoids						
1	Pimpla	*Gotra octocinctus* (Ashmead)	Hymenoptera	Ichneumonidae	+	+
2	Wasp	*Diaeretiella rapae* (McIntosh)	Hymenoptera	Braconidae	+	+
3	Braconid wasps	*Atanycolus sp.*	Hymenoptera	Braconidae	+	+
4	Chalcid wasp	*Eurytoma brunniventris* Ratzeburg,	Hymenoptera	Eurytomidae	+	+
	Total				4	4
	Relative abundance (%)				50.00	50.00
C. Pollinators						
1	Honey bee	*Apis mellifera* Linnaeus	Hymenoptera	Apidae	+	+
2	Honey bee	*Apis dorsata* Fabricius	Hymenoptera	Apidae	+	+
3	Carpenter Bee	*Xylocopa spp.*	Hymenoptera	Apidae	+	+
4	Honey bee	*Apis cerana* Fabricius	Hymenoptera	Apidae	+	+
	Total				4	4
	Relative abundance (%)				**50.00**	**50.00**

were parasitoids, and 4 were pollinators. Ladybird beetle was the foremost group of predators with five species [*Harmonia axyridis*; *Coccinella transversalis*; *Coccinella septempunctata*; *Menochilus sexmaculatus*; *Cheilomenes sexmaculata*]. Other predators were Aphidlion, Milky dartlet, Praying mantid, Syrphid flies, and Spider (unidentified). The relative abundance of predators during 2021-22 (57.14%) was comparatively higher than during 2020-21 (42.86%) (Table 2A).

The parasitic wasp was the major parasitoids species found parasitizing both nymphal and adult stages of aphid. The substantial parasitization of aphid by the wasp was noticed during both the seasons (Table 2B). Pimpla, Braconid wasps, and Chalcid wasp, were other parasitoids. Similar activity of different species of *Coccinella* reported by Firake *et al.,* 2013. He reported that *C. septumpunctata* and C. *transversalis* are the most dominant predators of aphids throughout the season. The present finding agreed with Das, 2020, who reported the sixteen species of natural enemies being associated with the brassicaceous crops in Assam. Among them, *Coccinella transversalis*, *Menochilus sexmaculatus*, *Syrphus spp* frequently occur as predators of aphids in brassicaceous crop of Meghalaya. Patel *et al.,* (2019) reported that *Coccinella septempunctata* and *Apanteles glomeratus* are important predator, and *Diaeretiella rapae* is the parasitoid generally associated with rapeseed-mustard ecosystem at Pantnagar, Uttarakhand.

The pollinating activity of different arthropods was also noticed. Among them, Honey bee and carpenter bee (*Xylocopa spp.*) were the major pollinators associated with the crop during both seasons (Table 2C). Three different species of honeybees (*Apis mellifera, Apis dorsata, Apis cerana*) visited the crop. During both seasons, the relative abundance of parasitoids and pollinators respectively was identical. Sihag, 1986 reported that honey bees are the major pollinators in Indian mustard. Dhakal, 2003 reported 20 different species pollinating mustard and confirmed that *Apis mellifera, Apis dorsata, Apis cerana* and *Xylocopa spp* are the most dominating ones.

The crop was also visited by 21 species of other

Table 3. List of other arthropods visited in mustard ecosystem

Sl. No.	Common name	Scientific name	Order	Family	2020-21	2021-22
1	Ants	*Camponotus sp.*	Hymenoptera	Formicidae	+	+
2	Ants	*Dolichoderus sp*	Hymenoptera	Formicidae	+	+
3	Beet webworm moth	*Spoladea recurvalis* (Fabricius)	Lepidoptera	Pyralidae	+	+
4	Broom Psyllid	*Arytainilla spartiophila*	Hemiptera	Psyllidae	+	+
5	Common evening brown	*Melanitis leda*	Lepidoptera	Nymphalidae	+	+
6	Common grass yellow	*Eurema hecabe* (Linnaeus)	Lepidoptera	Nymphalidae	+	+
7	Cow bug/Treehopper	*Oxyrachis tarandus*	Hemiptera	Membracidae		+
8	Fruit fly	*Drosophila melanogaster* Meigen	Diptera	Drosophilidae		+
9	Green leafhopper	*Empoasca decipiens* Paoli	Hemiptera	Cicadellidae	+	+
10	Handmaiden moth	*Syntomoides imaon* (Cramer)	Lepidoptera	Erebidae		+
11	Indian Cotton Stainer	*Dysdercus cingulatus*	Hemiptera	Pyrrhocoridae	+	+
12	Jersey mocha moth	*Cyclophora ruficiliaria* (Herrich-Schäffer)	Lepidoptera	Geometridae	+	+
13	Monarch butterfly	*Danaus plexippus*	Lepidoptera	Nymphalidae	+	+
14	Rice bug	*Leptocorisa oratorius*	Hemiptera	Alydidae		+
15	Shore flies	*Ephydra riparia*	Diptera	Ephydridae		+
16	Short Black Fly	*Simulium truncatum* (Lundstrom)	Diptera	Simuliidae		+
17	Small Black Wasp	*Priocnemis minorata* Banks	Hymenoptera	Pompilidae	+	+
18	Snout moths	*Pyralis farinalis* Linnaeus	Lepidoptera	Pyralidae		+
19	Tussock moth	*Orgyia spp.*	Lepidoptera	Erebidae		+
20	Tussock moth	*Euproctis plagiata*	Lepidoptera	Erebidae	+	+
21	Yellow tail moth	*Euproctissimilis fuessley*	Lepidoptera	Lymantriidae	+	+
	Total				13	21
	Relative abundance (%)				**38.23**	**61.77**

+ denotes presence

insects (Table 3) like Ants, *Camponotus sp., Dolichoderus sp*; Beet webworm moth *Spoladea recurvalis*; Among casual visitors, the majority were Lepidopterans followed by Hemipterans, Dipterans and Hymenopterans. Maximum relative abundance was recorded during 2021-22 (61.77%) than 2020-21 (38.23%).

Nowadays, due to intensive cultivation practices, rampant use of chemicals for controlling the biotic stress of plants, deforestation for conventional farming, and lack of habitat all are key components of loss the arthropod diversity, species richness, dominance, and abundance. Intensive application of chemical insecticides does not only kill pests but also insects that play some roles as natural enemies of predators, parasitoids, and other useful insects. (Arfan *et al.*, 2018). Indiscriminate use of synthetic chemicals leads to the loss of the biodiversity in many natural processes like decomposition of organic matter, pollination, crop production, *etc*. (Singh, 2020). In contrast, organic management practices help to enhance the biodiversity. The present study was conducted under organic cultivation practices and confirmed fifty-nine different species of arthropods with substantial parasitism of aphid by *Diaeretiella rapa*.

Conclusion

Fifty-nine different arthropods were recorded belonging to 12 different orders. The insect pests recorded includes mustard aphid, Mustard Sawfly, Diamondback moth, etc. The helpful activities of twenty-two arthropods were also noticed. Among them, different species of honey bees were the dominating pollinators and *Coccinella transversalis* and *Cheilomenes sexmaculata* were major predators. The substantial parasitization of aphids by *Diaeretiella rapae* was also documented. From the study, it is evident that organic crop cultivation practices may support to enhance the diversity of different living organisms. The degree richness of the biodiversity is one of the indicators of the healthy ecosystem.

References

Arfan, A. A., Basri, Z. and Toana, H. 2018. Effect of Chemical Insecticides on the Arthropod Diversity in the Agroecosystem of Red Onion Crops. *Asian Journal of Crop Science*. 10(3): 107-114.

Bhat, D. M. 2018. Incidence and diversity of lepidopterous insect pests and their parasitoids (natural enemies) on cole crops at Danderkhah location in Srinagar District (J&K, India). *International Journal of Entomology Research*. 3(2): 107-113.

Culliney, T. W. 2013. Role of arthropods in maintaining soil fertility. *Agriculture*. 3(4): 629-659.

Dhakal, G. 2003. Efficiency of *Apis mellifera* L. and *Apis cerana* F. for pollinating mustard and buckwheat. M.Sc. Thesis, Institute of Agriculture and Animal Sciences, Rampur, Chitwan, Nepal.

Das, R. 2020. A field study on insect pest complex of brassicaceous crops in some areas of Cachar, Assam. *Journal of Entomology and Zoology Studies*. 8(4): 2043-2045.

Firake, D. M., Lytan, D. and Behere, G. T. 2013. Bio-diversity and seasonal activity of arthropod fauna in brassicaceous crop ecosystems of Meghalaya, North East India. *Molecular Entomology*. 3(4): 18-22.

Jana, B., Paul, T., Pathak, S. and Dhote. V. W. 2021. Population dynamics of mustard aphid, *Lipaphis erysimi* (kalt.) in relation to weather parameters infesting organically cultivated mustard. *Multilogic in Science*. XI (XXXVIII): 1961-1962.

Mandal, E., Amin, M. R., Rahman, H. and Akanda, A. M. 2019. Abundance and diversity of arthropods in mustard. *Bangladesh Journal of Ecology*. 1(2): 53-56.

Nayak, U.S., Das, C. K., Khuntia, A., Pati, P. and Mohanty, T.R. 2022. Major Insect Pest of Mustard and their Integrated Management. *Indian Farmer*. 9(12): 579-584.

Patel, S., Singh, C. P. and Yadav, S. K. 2019. Monitoring of insect-pest complex on rapeseed-mustard at Pantnagar. *Journal of Entomological Research*. 43(1): 73-76.

Roy, S., Bhaumik, S., Imam, I., Chatterjee, T., Roy, K. and Mitra, B. 2016. A preliminary study on the succession of insect visitors and their symbiotic interaction for effective pollination in *Brassica juncea* (L.) of southern West Bengal. *International Journal of Advanced Research*. 4(8): 1762-1768.

Sharif, M. S., Jabeen, A., Tariq, M., Shahzad, K., Latif, S., Zahra, H., Awaiz, M. D. and Asif, S. 2022. Diversity and abundance of insects on Potato, Mustard, and Tomato in winter at Mitchells farm, Okara, Pakistan. *GSC Biological and Pharmaceutical Sciences*. 18(1): 36-40.

Singh, S. 2020. Scenario of arthropod diversity in organic farming system. *International Journal of Plant Protection*. *13*(1): 117-124.

Yadav, S. K., Singh, R. B., Gautam, M. P., Singh, G. and Giri, S. K. 2018. Bio-efficacy of insecticides against mustard aphid (*Lipaphis erysimi* Kalt.) on mustard (*Brassica juncea* L.). *International Journal of Chemical Studies*. 6(2): 2704-270.