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Studies on Insect-pests Complex of Rapeseed Mustard and their Natural Species in Roorkee Region, Uttarakhand, India

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ABSTRACT: A field experiment was carried out to study the insect pests associated with rapeseed mustard in Roorkee region of Uttarakhand's Haridwar district during 2021 and 2022 rabi season. In this region, rapeseed mustard was linked to a pest complex of roughly eight different insects-pests species. The Mustard aphid, *Lipaphis erysimi* has been found consistently expand in population and causing economic damage to mustard crop. It occurred from flowering to till maturity stage of the crop, while mustard sawfly, *Athalia lugens proxima* and flea beetle, *Phyllotreta cruciferae* occurred during seedling stage and painted bug, *Bagrada cruciferarum* damaged the crop during seedling to maturity stage as a minor pest. At the vegetative stage, the cabbage aphid *Brevicoryne brassicae,* the cabbage butterfly *Pieris brassicae,* and the rose aphid *Macrosiphum rosae* were all seen in sporadic, low-population occurrences. Only the mustard aphid, a regular important pest/major pest, does the most harm to mustard crops out of the eight insect pests that were identified. The other seven pests were all categorised as minor. In the experimental crop, four natural enemies of several insect pests of rapeseed mustard were identified: dragonflies, ladybird beetles, green lacewings and braconid wasps. Insect pests complex cause major crop losses in agriculture worldwide. Therefore, to identify a key pest of a particular crop and their damaging stages on crop is crucial to effectively control the economic crop yield losses and also to reduce cost benefit ratio of insecticide applications and by also identifying their natural enemies we can reduce the application of chemical insecticides.

Keyword: pests, rapeseed-mustard, brassica species, natural enemies and pest complex.

INTRODUCTION

The family Brassicaceae (cruciferae) is one of the 10 most commercially significant plant families consisting of about 3500 species and 360 genera (Warwick *et al.*, 2000). India is third largest rapeseed- mustard producer in the world only to China and Canada with 12 % of world total production. In terms of production, rapeseed-mustard comes in second place after soybean among edible oilseeds and accounts for more than 30% of edible oil production in India. The rapeseed-mustard group of crops consists of mustard/raya, toria, brown sarson, yellow sarson, gobhi sarson, black mustard and taramira. The crops cover 6.01 million hectares and produce 8.04 million tonnes with an average productivity of 1339 kg per hectare (AICRPRM, 2018). The crop has occupied 25 lac hectare areas and produces 10.10 million tonnes. Next to soybean and peanuts, rapeseed-mustard is India's third-most significant source of edible oil. It is cultivated as a cold-season crop in several tropical and subtropical areas (Shekhawat *et al.,* 2012). The key mustard-growing states in India include Rajasthan, Uttar Pradesh, Madhya Pradesh, West Bengal, Haryana, Punjab, and Assam. Due to numerous abiotic and biotic stresses, India's average yield of rapeseed and mustard crops is quite poor. Aphid (*Lipaphis erysimi*) and Painted bug (*Bagrada cruciferarum*) are the two most significant insect pests of mustard, endangering the crop from the time it is sown until end of the growing season. This significantly decreased the yield potential of rapeseed mustard (Chattopadhyay *et al.*, 2005). In all the mustard growing regions of the country, the aphid, *L. erysimi*, is the most significant key pest. The mustard aphid is the most destructive pest in rapeseed mustard. From December through February, mustard aphid infestations take place in the field. From seedling to maturity, both the adults and nymphs of this aphid cause damage to mustard plants, but maximum damage is caused at flowering stage (Ahmed and Jalil 1993). The ecological approach to the pest management suggests use of pesticides only when and where absolutely essential. Hence, the current study was conducted to examine the variations in the mustard aphid population and its predators in relation to weather parameters in order to ensure an efficient and cost-effective control of this significant pest.

Damage caused by numerous insect pests is one of the many causes contributing to the low yield of mustard. To develop future transgenic brassicaceae vegetable plants, it is necessary to study various insect pests (Shelton *et al.*, 2009). Rai (1976) identified a total of 24 species of key insect pests that were responsible for

severe infestation at various phases of crop development. *Athalia lugens proxima* (Klug), the mustard saw fly, *Lipaphis erysimi* (Kalt), the painted bug, *Bagrada hilaris* (Burmeister), and the leaf miner, *Phytomyza horticola* (Goureau), are among the key insect pests of the rapeseed-mustard crop that Purwar *et al.* (2004) recorded in India. The mustard aphid, *L. erysimi* (Kalt), has been identified as the most significant insect pest among them, infesting the crop from the seedling stage through maturity and resulting in production losses of up to 96% (Singh and Sachan 1994; Sharma and Kashyap 1998; Singh and Sharma 2002). *A. lugens proxima* Klug, often known as the mustard sawfly, has become a significant pest of mustard and radish in various Indian states, particularly the north-east (Narayanan and Gopalakrishnan 2003; Chowdhury, 2009). It is a cold-weather pest that typically operates from October to March. Mustard sawfly attacks the crop when the seedlings are 3-4 weeks old (Bogawat, 1967; Sehgal *et al.*, 1975; Verma and Sachan 1997; Pradhan *et al.*, 2020a). *A. proxima* alone assault may cause a full decrease in yield in some circumstances, although on average, the decline in yield is only approximately 25% (Sachan, 1990). A few entomopathogenic fungi are very effective at managing insect pests of mustard in a balance agro ecosystem, where many helpful biocontrol agents are constantly present to maintain equilibrium (Pradhan *et al.*, 2020b). At a later stage of crop development, when mustard aphids have already done the majority of the harm, natural enemies like *Chrysoperla* spp. and lady bird beetles, *C. septempunctata*, start to appear. In addition, populations of these two natural enemies are insufficient to significantly lower aphid populations (Aslam and Razaq 2007).

MATERIALS AND METHODS

The current investigation on the rapeseed-mustard insect pest complex was carried out at the Quantum University, Roorkee in India during rabi season 2021 and 2022. A randomized block design was used to set up the experiment. Row to row and plant to plant distances on the 5 m × 4 m area plot size were 30 cm and 10 cm, respectively. In the trial field, the seed was sown on 15th October, during Rabi season 2021 and 2022. At the time of sowing, half of the recommended nitrogenous fertilizer dose (60 kg N/ha), the full dose of phosphatic fertilizer (60 kg P_2O_5/ha) and the full dose of potassic fertilizer (40 kg K_2O/ha) were applied as basal application. The remaining nitrogenous fertilizer was then applied as a top dressing during flowering. Hand weeding was done to keep the experimental plots free from weeds. Five plants were tagged at random from each plot, and an observation of insect pests was noted. Data were gathered in the early morning at intervals of seven days, commencing on germination day and ending on the last day (harvest). To assess the pests' economic status, the nature and amount of damage caused by various insect pests was also recorded. The insect pests were gathered and raised to adulthood wherever it was necessary. Adult insects were preserved and identified. The collected adult insects were killed in killing bottle, mounted either on insect pins or paper points depending on its size and labelled properly.

RESULT AND DISCUSSION

During this experiment, four natural enemy species and eight insect pest species were identified at various growth stages of the mustard crop. In which the orders Hemiptera accounted for four, Lepidoptera for two, Hymenoptera for two, Coleoptera for two, and one each belonged to the order odonata, and neuroptera. In this Roorkee region, the rapeseed mustard aphid, *Lipaphis erysimi* (Aphididae: Hemiptera), has been identified as the most destructive and significant pest. The last week of December marks the beginning of this pest's emergence and the end of January marks the peak of its population. The current research supports the findings of Mishra and Kanwat (2018), reported the maximum aphid population reached to its peak in the last week of January. The nymphs and adults feed on the sap of leaves, new shoots, inflorescence, and young pods, causing the leaves to curl, shrivel, and become yellow due to a loss in chlorophyll. This type of damages was also documented by Patel *et al*. (2019); Patel *et al*. (2017). Sahoo (2012) also reported that mustard aphid is the most serious insect pest of mustard and responsible for crop yield losses ranging from 35.4 to 96 per cent depending upon weather condition.

In this region, the Mustard Saw Fly, *Athalia lugens proxima* (Tenthredinidae: Hymenoptera), is regarded as a minor pest of rapeseed mustard from mid-October to last December. It was spotted in the mustard field at seedling stage. The current findings concur with research finding of Patel *et al*. (2019). Four significant insect pests, including the mustard sawfly (*Athalia lugence proxima*), mustard aphid (*Lipaphis erysimi*), cabbage butterfly (*Pieris brassicae*), and painted bug (*Bagrada hilaris*), have been recorded by Patel *et al.* (2022). These pests cause the most damage to mustard crops at various growth stages.

The incidence of the agricultural pest, the cabbage butterfly; *Pieris brassicae* (Pieridae: Lapidoptera), began in mid-December and continued until last April. According to the level of infestation it was considered as minor pest of rapeseed mustard and the pest infestation was observed from the crop's vegetative stage to maturity stage. The current findings are in agreement with that of Patel *et al*. (2019). Bhati *et al*. (2015) also noted that the rapeseed-mustard crop was attacked by the cabbage butterfly (*P. brassicae*) at various growth stages. The infestation of cabbage aphid, *Brevicoryne brassicae* (Linn.) (Aphididae: Hemiptera) observed on the crop from October until last April, is regarded as a minor pest in this area that affects rapeseed mustard. The sap from growing shoots and inflorescences is drained by both nymphs and adults, which restricts growth and encourages the spread of sooty mould. Yadav and Patel (2017) also reported on this type of damage caused by cabbage aphid. The nymphs and adults of the rose aphid, *Macrosiphum rosae* (Aphididae: Hemiptera), suck the sap from leaves, new shoots, and flower buds. From

mid-February until last March, it was noticed on the crop. It is regarded as a minor pest on rapeseed-mustard in this area.

Plutella xylostella, a diamond black moth (Plutellida: Lepidoptera), was observed from mid-October to last December. The spongy mesophyll tissue was mined by the pest's larvae. Old larvae feed later on the tissue from the bottom surface of the leaf, excluding the wax layer on the upper surface, forming a "window" in the leaf. Moreover, this pest's damage has been also documented by Patel *et al*. (2019). It is usually seen in a mustard field during the vegetative stage and is regarded as a minor pest on rapeseed-mustard in this area.

Painted bug *Bagrada cruciferarum* (Pentatomidae: Hemiptera) (Pentatomidae: Hemiptera) have been observed between the months of October and March. It is regarded as a minor pest on rapeseed-mustard in this area based on its abundance. The incidence of this pest started from the seedling to maturity stage of crop growth. The current findings concur with the findings of Patel *et al*. (2019). By sucking the sap from leaves as they grew from seedling to maturity and from growing pods, nymphs and adults both contributed to the wilting and drying of the affected plants. The damage of this pest has also been reported by Patel *et al.* (2017b). The current findings are consistent with those of Pal *et al.* (2020), who discovered that the painted bug, *Bagrada cruciferarum* (Kirk.), was prevalent during two distinct crop stages: the seedling stage and the maturity stage. According to Bhati *et al.* (2015), the painted bug appears at different growth stages of the rapeseed mustard crop.

Phyllotreta cruciferae (Goeze), a flea beetle (Chrysomelidae: Coleoptera). The crop was affected by this pest from October through last December. On the basis of its prevalence, it is regarded as a minor pest of rapeseed mustard in this area. The flea beetle's adults eat the cotyledons and leaves and make holes in the tender leaves. Patel *et al.* (2017a) have also reported the damage caused by this pest.

Cheliomenes sexmaculata, the lady bird beetle (Coccinellidae: Coleoptera). From early December until mid-April, the occurrence of this beetle was observed. Aphid, *erysimi*, cabbage aphid, and rose aphid were all found to have *coccinella septempunctata*. Around the end of March, the aphid population begins to decrease. Singh *et al.* (2000) to record the Coccinellid predators associated with mustard aphid, *L. erysimi* infesting mustard crop revealed that four species of coccinellids *viz, C. septempunctata, C. transversalius, C. sexmaculata* and *B. suturalis* were present. Among these, *C. septempunctata* and *C. transversalis* were important aphidiphagous Coccinellid predators of the mustard aphid.

Diaeretiella rapea, a braconid wasp (Braconidae:Hymenoptera). From early December until mid-April, the occurrence of this wasp was observed. It was observed that braconid wasp is a major parasitoid in the rapeseed mustard crop, feeding the number of mustard aphids. The current findings concur with Patel *et al*. (2019) research work.

Green lacewing bug: *Chrysoperla carnea* (Chrysopidae: Neuroptera) green lacewings insects are usually bright green to greenish-brown; it was recorded on the crop from mid-October to starting April.

Dragon fly: *Crocothemis servilia* (Libellulidae: Odonata) Dragonflies are -flying insects, heavy-bodied and membranous wing. It was recorded on the crop from starting October to last April.

Several studies have revealed that various insect pests damage rapeseed-mustard at different locations throughout India. According to Rai (1976), out of 24 insect pests reported from India, *L. erysimi*, *A. lugens proxima* and *B. cruciferarum* were considered to be the major pests, while *P. cruciferae* (Goeze), a type of flea beetle, and *P. brassicae* L., *M. persicae* Sulzer, and *P. xylostella* Lin, a type of cabbage butterfly, were minor pests. *L. erysimi* is now considered as national insect-pest (AICRP, 2015).

Table 1: Insect -Pest complex on mustard crop in Roorkee region of Uttarakhand during Rabi seasion-2021 and 2022.

Sr. No.	Common name	Scientific name	Family and order	Damaging stage	Crop growth stage	Period of activity	Economic status
1.	Mustard saw fly	*Athalia lugens proxima*	Tenthredinidae Hymenoptera	Larvae	Seedling	Mid October to last December	Low
2.	Cabbage butterfly	*Pieris brassicae*	Pieridae Lepidoptera	Larvae	Vegetative to Early Maturity	Mid December to last April	Medium
3.	Diamond black moth	*Plutella xylostella*	Plutellidae: Lepidoptera	Larvae	Vegetative	Mid October to last April	Medium
4.	Mustard Aphid	*Lipaphis erysimi*	Aphididae: Hemiptera	Nymph and Adult	Flowering	Starting December to last March	High
5.	Flea beetle	*Phyllotreta cruciferae*	Chrysomelidae Coleoptera	Adults	Seedling	Mid October to last December	Low
6.	Rose Aphid	*Macrosiphum rosae*	Aphididae: Hemiptera	Nymph and Adult	Flowering	Mid Feb to last March	Stray
7.	Cabbage Aphid	*Brevicoryne brassicae*	Aphididae: Hemiptera	Nymph and Adult	Vegetative	March to first week of April	Low
8.	Painted Bug	*Bagradac ruciferarum*	Pentatomidae Hemiptera	Nymph and Adult	Vegetative to maturity	Last Oct. last week of March	Low

Table 2: Natural enemies complex on rapeseed mustard crop at Roorkee Uttarakhand during Rabi-2021 and 2022.

Sr. No.	Common name	Scientific name	Family and order	Period of activity
1.	Lady bird beetle	*Cheliomenes sexmaculata*	Coccinellidae Coleoptera	Starting December to mid-April
2.	Dragonfly	*Crocothemis servilia*	Libellulidae Odonata	Starting October to last April
3.	Green lacewing bug	*Chrysoperla carnea*	ChrysopidaeNeuroptera	Mid October to starting April
4.	Braconid wasp	*Diaeretiella rapea*	Braconidae Hymenoptera	Starting December to mid-April

Mustard aphids infestation at different growth stages of mustard crop.

CONCLUSIONS

This study identified numerous insect species that are associated with rapeseed mustard, portending a potential threat to rapeseed mustard production. Rapeseed mustard also contains species of natural enemies, including as parasitoids and carnivores. It is known that every reported predator and parasitoid has a direct relationship to their prey population. It is suggested that important biological control agents can be exploited in the management of the major insect pests of rapeseed mustard.

FUTURE SCOPE

Insect pests complex cause major crop losses in agriculture worldwide. Therefore, to identify a key pest of a particular crop and their damaging stages on crop is crucial to effectively control the economic crop yield losses and also to reduce cost benefit ratio of insecticide applications and by also identifying their natural enemies we can reduce the application of chemical insecticides.

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Conflict of Interest. None.

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