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Host preference of various aphid species on winter vegetables

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Abstract
Aphids, a significant emerging pest worldwide, have a broad impact on various hosts. This study aims to assess the specific host preferences of three aphid species: Pea Aphid (*Acyrthosiphon pisum* Harris), Mustard Aphid (*Lipaphis erysimi* Kat.), and Cabbage Aphid (*Brevicoryne brassicae* Linn.) on three different winter vegetables i.e. Cabbage, Garden pea, and Broadleaf Mustard. This research was conducted in the net house of AKS University, FAST campus, Satna, the research employed a two factorial CRD with three replications from January 2023 to February 2023. The statistical analysis revealed highly significant results for both aphid species and crop species, as well as their interaction, in terms of live aphid count. The interaction results indicated distinct host preferences, with Pea Aphid exclusively favoring legume crops (Garden pea). Cabbage Aphid and Mustard Aphid demonstrated preferences for Cabbage and Broadleaf Mustard, respectively. In Broadleaf mustard, the initial population count of Cabbage Aphid was higher, but over the time (34 days post-inoculation), Mustard Aphid increased at a faster rate, becoming statistically similar to Cabbage Aphid. Throughout the study period, the population of Mustard Aphid was consistently higher in cabbage. This comprehensive understanding of host preferences contributes to the enhancement of effective pest management programs against aphids.

Keywords: Cabbage aphid, host preference, inoculation, mustard aphid, pea aphid.

Introduction
Aphids, which are sap sucking pests, are increasingly recognized as a significant global pest (Vennila, 2008) [13]. These pests can directly damage host plants through feeding and indirectly through the transmission of viruses and honeydew excretion (Opfer and McGrath, 2013) [9]. The continuous feeding of aphids leads to symptoms such as yellowing, wilting, and stunting of plants. The Pea Aphid (*Acyrthosiphon pisum*), found worldwide, infesting crops such as faba bean (*Vicia faba* L.), lupin (*Lupinus albus* L.), alfalfa (*Medicago sativa* L.), lentil (*Lens culinaris* Medik.), chickpea (*Cicer arietinum* L.), and pea (*Pisum sativum* L.) (Fernández *et al.*, 2019) [2]. Its broad host range, complex life cycle, including both sexual and parthenogenetic reproduction (Schmidtberg and Vilcinskas, 2016) [11], and its flexibility in adapting to different environmental conditions (Srinivasan *et al.*, 2014) [12] makes it difficult to control this pest.
Cabbage aphid *Brevicoryne brassicae* is distinguishable by the presence of very short cornicles and the waxy coating in its body. Cabbage aphid poses a significant challenge in the production of cauliflower, broccoli, and cabbage. This aphid species is confined to plants in the Brassicaceae family, which include both cultivated and wild cruciferous crops (Gabrys *et al*., 1997) [6].
The Mustard aphid (*Lipaphis erysimi*), distributed in tropical and subtropical regions globally, is acknowledged as a serious pest affecting mustard, cabbage, cauliflower, turnip, rai, toria, brocoli, and more (Atwal, 1976) [1]. *L. erysimi* is associated with substantial yield losses, seed weight reduction, and oil loss ranging from 35.4% to 96%, 30.9%, and 2.75%, respectively (Singh and Premchand, 2015) [10].
Aphids, particularly in herbaceous crops like vegetables, pose significant challenges to the productivity of cruciferous vegetables worldwide. Each aphid species exhibits a distinct host range for feeding and reproduction, contributing to varying levels of infestation (Capinera, 2001) [4]. Despite the importance of understanding host preferences, there is a lack of research addressing the specific host range and preferences of different aphid species.

This experiment was conducted to investigate the host preferences of various aphid species on major winter vegetables and to assess the host-based infestation of these aphid species.

Materials and Methods

The experiment was conducted in net house of Faculty of Agriculture Science and Technology, AKS University, Satna (M.P.) Which is located at 24º 34' North in longitude from 80º 49' east at an altitude of 324m above sea level using a two-factorial Complete Randomized Design (CRD). Three common winter vegetables *viz*. Cabbage (*Brassica oleracea* L.), Broad Leaf mustard (BLM) (*Brassica juncea* L) and Garden pea (*Pisum sativum* L.) are treated as one factor and three common aphid species *viz*. Cabbage Aphid (*Brevicoryne brassicae* Linn.), Mustard Aphid (*Lipaphis erysimi* Kat.) and Pea Aphid (*Acyrthosiphon pisum* Harris) as next with three replications. Observations were taken on every seven days from the day of inoculation and obtained observations were analyzed with the help of MS-Excel.

Pure Culture Preparation

A laboratory reared a pure culture of aphid species were collected from farmer fields in the Satna district. The rearing process followed to Johnson's method (Huges and Woolcock, 1965) [8] with two individuals of each species placed in a petri dish lined with sterilized tissue paper to maintain the required moisture level at an average laboratory temperature of 28 ˚C. These aphids were provided with fresh leaves of the host crop daily for nourishment. Only new emerged progeny were retained, and the parental line was consistently discarded through multiple cycles to maintain the purity of the stock culture of aphid species.

Plantation of Crop (Host)

Crops were cultivated inside the poly house with 20 cm spacing. Seeds were obtained from a local agriculture shop. Varieties of crops were Arkel, Kala sona and Pusa Mukta for Garden pea, BLM and Cabbage, respectively. Cabbage was transplanted 30 days after nursery establishment, while the other two crops were directly seeded.

Inoculation of Stock Culture

In the experiment, each plant species was inoculated with aphids from the pure culture, after 30 days of transplanting for transplanted crops and 30 days after sowing in case of directly seeded crops. Two individual aphids were inoculated on each plant, and the confinement of aphid species to their respective plants was ensured using insect netting with a mesh size of 2 mm.

Result and discussion:

All Aphid species showed the significant result with mean population count. *Acyrthosiphon pisum* was found to grow rapidly as compare to *L. erysimi* and *B. brassicae* in the initial phase (Seven days after inoculation) whereas, BLM was affected more in the last date of the count.

Similarly, it was found that crop species also significantly effective in the mean population count of live aphids. Garden pea harbor maximum population count at Seven days of inoculation followed by BLM and Cabbage. Then, the population count was rapidly increased in BLM from 21 DAI till final days followed by Cabbage and Garden pea which were statically similar.

The interaction result of both factors (reveled in Table-1) signifies the host preference. The date wise performance of different aphids on the different host is interpreted as.

Seven days after Inoculation

Seven days after inoculation, *A. pisum* was found to be dominant in garden pea than any other interaction. In Cabbage, *B. brassicae* grow predominantly high which was significantly different from mustard aphid and pea aphid. Whereas, in Broadleaf mustard, *B. brassicae* was dominant over *L. erysimi* and *A. pisum*. The host garden pea was less preferred by *B. brassicae* and *L. erysimi*.

Fourteen days after Inoculation

After 14 days of inoculation, Growth of *A. pisum* in garden pea was quite high in comparison to other aphids. This aphid showed poor interaction with two other crops. In cabbage, *L. erysimi* population showed significant result followed by *B. brassicae and A. pisum*. and, In case of BLM, *B. brassicae* population was found greater than that of *L. erysim* and *A. pisum.* During this stage, the aphid *A. pisum* inoculated at cabbage and BLM were totally dead.

Twenty-one days after Inoculation

In Twenty-one days of inoculation, Growth of *A. pisum* in garden pea was outstanding but its growth and preference on both crops (cabbage and BLM) was totally neglected. And both the crucifers also resist the growth of *A. pisum* due to which inoculated *A. pisum* on that host were totally dead. Here, in cabbage, *L. erysimi* showed significant result followed *by B. brassicae*. And, In BLM, *B. brassicae* population was significantly higher than the *L. eryisimi*.

Twenty-seven days after Inoculation

Twenty-seven days after inoculation, the growth of *B. brassicae* in BLM was highest than any other interaction, which was statically similar with *A. pisum* in garden pea. The growth rate of *L. erysimi* was following *B. brassicae* in BLM. In the case of cabbage, the population of *L. erysimi* was significantly higher than that of *B. brassicae*. Here, both crops resist the growth of *A. pisum* which was only concentrated in garden pea.

Thirty four days after Inoculation

During 34 days of inoculation, Mean population of *B. brassicae* in BLM was found to be highest which was significantly similar with *L. eryisimi*. Similarly, In the case of cabbage, the population of *L. eryisimi* was significantly higher than that of *B. brassicae*. Here, the host cabbage and BLM was totally rejected by *A. pisum* which prefers only the host garden pea. And the host garden pea was also totally rejected by both the aphid i.e. *B. brassicae* and *L. erysimi.*

The growth of given aphids is predominantly guided by the content of the allelochemicals known as Glucosinolates on these plant species (Francis *et al.*, 2001) [5]. Glucosinolates (GLS), a group of thioglucoside compounds which may function as feeding deterrents or toxins for some herbivorous insects, most pests of Brassicaceae species, in particular aphids, are attracted and stimulated to feed and oviposit by allyl isothiocyanate or its GLS precursor, sinigrin (Huang and Renwick, 1994) [7]. While assessing the

Glucosinolates levels in shoots of different Brassica crops higher level of GSL were found to be in leaf Mustard (61.76 µmol·g^{-1} dry weight) than in Cabbage (8.84 µmol·g^{-1} dry weight) (Bhandari *et al.*, 2015) [3]. They also observed Garden pea, *Pisum sativum* L. as GLS free.

In this research, the higher preference of *L. erysimi* towards Cabbage is guided by the lower concentration of Glucosinolates present in BLM which was demonstrated also by Franchis *et al*., 2001 [5]. Similarly, the preference of GLS Free *Pisum sativum* was limited to *A. pisum* only.

As the host garden pea is free from GLM, it was not preferred by *L. erysimi* and *B. brassicae* which is supported Wensler, 1962 [14], where he found the non-host plants, *Vicia faba and Pisum sativum* was accepted by the cabbage aphid after excised plant parts had been treated with a 2% GLM solution. In case of BLM, this research count *B. brassica* higher in the initial stage of the host but in maturity level, the *L erysimi* seems to increase which may be due to the fact that glucosinolate label decrease with the maturity of the host shown in (Table 2).

Table 1: Effect of Aphid species and crop species on mean population count in different days of inoculation in polyhouse of AKS, FAST campus, 2023

Factor A (Aphid species)	**7 DAI**	**14DAI**	**21DAI**	**27DAI**	**34DAI**
Acyrthosiphon pisum	42.11	87.42	204.03	335.23	686.56
Lipaphis erysimi	7.12	67.85	226.65	532.42	1421.12
Brevicoryne brassicae	18.54	44.32	172.75	325.78	1154.65
F test at 5%	***	**	*	***	***
Factor B (Aphid species)					
Cabbage	11.24	54.74	132.25	330.12	765.44
Garden pea	47.84	95.97	224.95	357.64	714.78
Broad leaf Mustard	18.76	68.33	264.15	657.35	1987.24
F teat at 5%	***	***	***	***	***
LSD	3.45	15.96	39.24	58.67	102.64
CV%	12.68%	20.89%	17.82%	13.57%	8.94%
Mean	24.27	69.77	204.13	423.09	1121.63

Interaction effect	**7 DAI**	**14DAI**	**21DAI**	**27 DAI**	**34DAI**
Cabbage v/s *A. pisum*	1.97	0.00	0.00	0.00	0.00
Cabbage v/s *L. erysimi*	8.66	118.67	324.45	768.21	1865.24
Cabbage v/s *B. brassicae*	14.32	29.35	68.32	217.85	419.87
G. pea v/s *A. pisum*	144.15	277.54	684.78	932.56	2120.41
G. pea v/s *L. erysimi*	8.44	2.56	0.00	0.00	0.00
G. pea v/s *B. brassicae*	2.24	0.88	0.00	0.00	0.00
BLM v/s *A. pisum*	2.28	0.33	0.00	0.00	0.00
BLM v/s *L. erysimi*	8.42	88.74	266.56	786.87	2804.25
BLM v/s *B. brassicae*	46.22	132.44	460.24	1014.33	2966.76
F-test at 5%	***	***	***	***	***
LSD	5.78	27.88	68.74	102.44	172.92
CV%	12.66%	20.47%	17.56%	12.32%	8.54%
Mean	26.30	72.28	200.48	413.31	1130.73

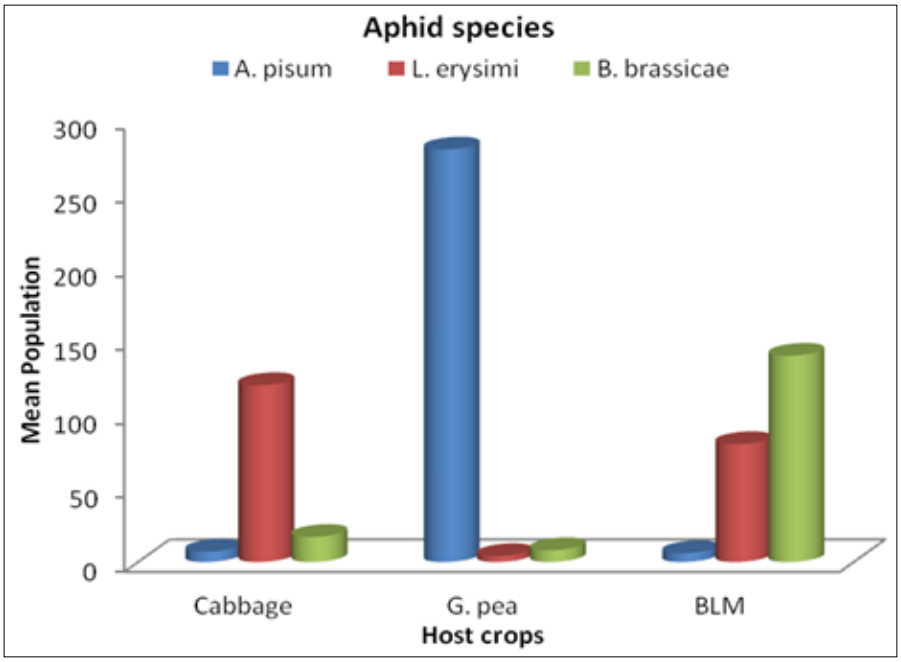

Fig 1: Seven days of inoculation

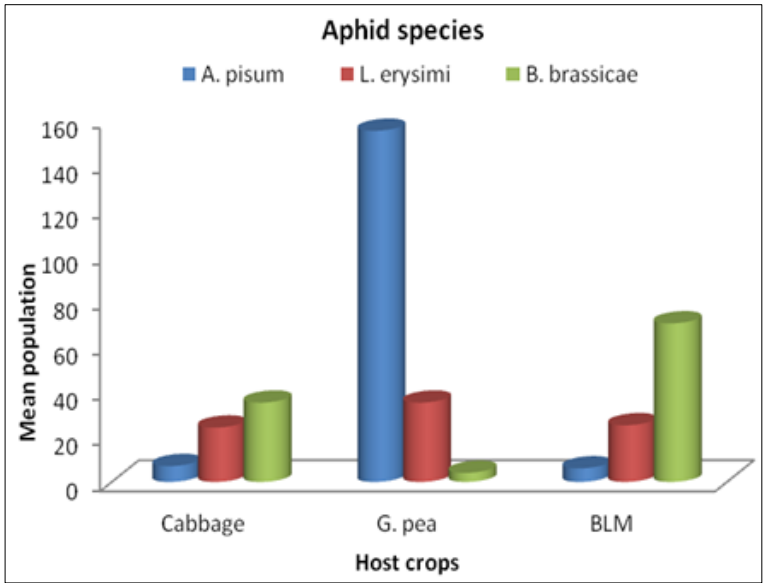

Fig 2: Fourteen days of inoculation

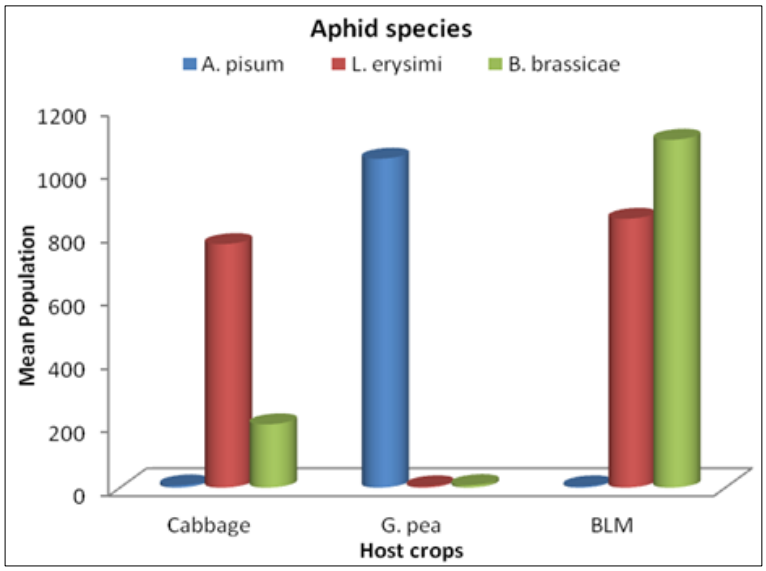

Fig 3: Twenty one days of inoculation

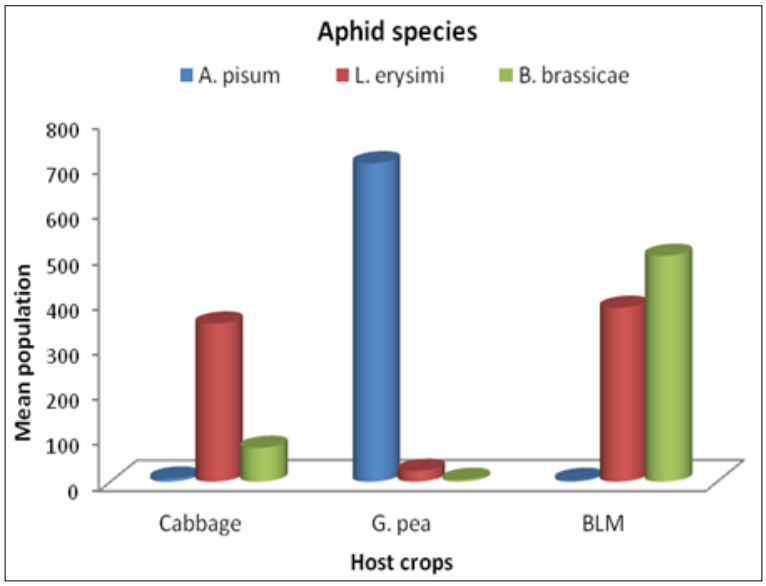

Fig 4: Twenty seven days of inoculation

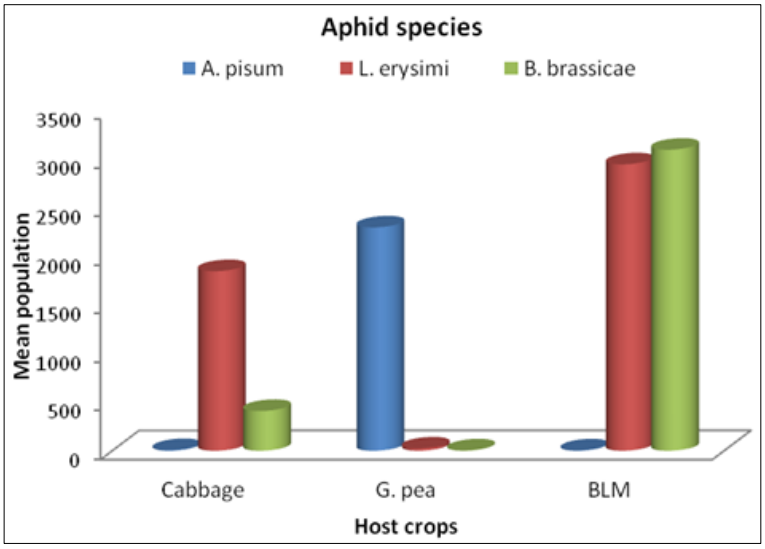

Fig 5: Thirty one days of inoculation.

Conclusion

The statistical analysis showed highly significant outcomes for both factors aphid species and crop species along with their interaction, in terms of live aphid count. Initially, Aphid *A. pisum* was found highest count during the early stage of plant development, succeeded by *B. brassica* and *L. erysimi*. However, after 21 DAI, *L. erysimi* became more predominant. Similarly, the crop species also demonstrated highly significant results in mean population count. Garden pea was found to harbor more aphids in the early days, while BLM had a greater impact in later days, followed by cabbage and garden pea.

The interaction result which signifies the host preference suggested that among three different species of aphids used for the study, Pea aphids show their host preference towards the leguminous crops among the crops used in the study. Pea aphids infest the garden pea most severely than other crops. This gives the idea that Pea aphids are limited to the legume crops only. Other two species of aphid *viz*. Cabbage aphid and Mustard aphid both showed a greater affinity towards the cruciferous crops i.e. Cabbage and BLM. These two aphids both infest cruciferous to a greater extent, but among these two aphids, Mustard aphid is more devastating as these aphids attack in both cabbage and mustard crops.

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