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RESEARCH ARTICLE

Inventory of insect and arachnid fauna associated with broad bean (*Vicia faba* L.) in the Gangetic plain of Uttar Pradesh, India

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Abstract

Surveys for the insect and arachnid fauna associated with Broad bean in the Gangetic Plains of Varanasi, Sonebhadra and Deoria districts of Eastern Uttar Pradesh, India were carried out during the *rabi* seasons of 2023-25. Insects belonging to seven orders were recorded, which were found to be members of either phytophagous orders, *viz*., Lepidoptera, Hemiptera, Diptera, Coleoptera, and Thysanoptera, or predatory orders, *viz*., Coleoptera, Hymenoptera, and Dictyoptera, or were pollinators from the orders *viz*., Hymenoptera, Coleoptera and Diptera. Amongst the pests, serpentine leaf miner (*Liriomyza trifolii* and *Liriomyza sativae*) and black bean aphid (*Aphis craccivora*) were observed as major pests, as their damage was≥10%. The Bihar hairy caterpillar, *Spilosoma obliqua,* is a polyphagous pest and sporadic in nature. The other pests like tobacco caterpillar (*Spodoptera litura*), Coreid bug (*Cletus* sp.), Pentatomid bug (*Nezara viridula*), White spotted flea beetle (*Monolepta signata*), red spider mite (*Tetranychus* sp.), etc., were minor in nature to this winter legume vegetable. During the study, four predatory arthropod orders, *viz*., (Coleoptera, Hymenoptera, Dictyoptera and Araneae) and three pollinating insect orders (Hymenoptera, Coleoptera and Diptera) were also documented. For the first time, an inventory of the insects and arachnids related to this crop from this area is made in this publication.

Keywords: Broad bean, Survey, Insect and acarine fauna, Indo-Gangetic plains.

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Introduction

Broad bean or Faba bean (*Vicia faba* L.) (Family: Fabaceae) is an important annual legume crop grown widely (Jensen et al., 2010; Karkanis et al., 2018; Singh et al., 2012). Broad bean had already proven its potential and at present, this crop is grown in 58 countries (FAO, 2009; Singh *et al*., 2013). Its green pods are edible and mainly used as vegetables, whereas dry cotyledons are one of the excellent and cheap sources of lysine-rich protein (Bond, 1976; Hawtin and Hebblethpiait, 1983; Abdel, 2008). It is one of the suitable crops that can be used as green manure and one of the best bio-factory of fixing atmospheric nitrogen through symbiotic nitrogen-fixing bacteria found in their root nodules (Hoffmann *et al*., 2007; Horst *et al*., 2007). However, in India, this crop is still not fully exploited and the area under faba bean is very small; that's why it is still categorized as a minor or underutilized crop. It is a traditional legume crop of Bihar where it also occupies maximum area of broad bean and in India, it is also cultivated in Madhya Pradesh, Odisha, Jharkhand, Uttar Pradesh (mainly eastern part) (Singh *et al*., 2012), Punjab, Haryana, Rajasthan, Jammu and Kashmir, Karnataka (Thamburaj and Singh, 2005), Manipur, Mizoram, Arunachal Pradesh. However, the productivity of this lesser-known crop is significantly lower than that of many other crops. Crop

infestation by numerous insects and acarine pests and lack of pollination are causing significant yield losses in this crop (Mesbah *et al*. 2016; El-Dessouki, 2022).

Insects and mites are one of the major biotic constraints to agri-horticultural production in India. Apart from causing direct damage, many of them also act as vectors for viral diseases. The crop losses to the tune of 30-40 per cent have been reported from vegetable crops (Halder and Rai, 2021; Halder et al., 2022). Besides being pests, many insects also serve as beneficial, *viz*., pollinators, parasitoids and predators (Halder *et al*., 2017). Although the Faba bean (*V. faba)* is a partially allogamous species (self-fertile with about equal amounts of self and cross-pollination occurring, depending on the presence of insect pollinators) (Singh et al., 2013), the role of the insect as a pollinator also cannot be ruled out. According to Link (1990), the rate of outcrossing in Faba beans varies from 7 to 82% depending upon the genotype, environment and planting arrangement. Unlike other major leguminous crops, information on the association of various insect and acarine pests in India, their status and beneficial fauna like predators, parasitoids and pollinators on this underutilized leguminous pulse and vegetable is scanty. Information on the diversity and economic importance of pests and beneficial fauna is essential for designing any sustainable pest management strategies. Thus, the present study was carried out with the aim of identifying and cataloguing the diversity of insect and acarine fauna of Faba bean in the Gangetic belts of Uttar Pradesh as a first step towards the development of an effective integrated pest management strategy for this region.

Materials and Methods

Experimental site

The field experiments were carried out at the experimental farm of the Indian Council of Agricultural Research-Indian Institute of Vegetable Research (ICAR-IIVR), Varanasi (82°52′ E longitude and 25°12′ N latitude), Uttar Pradesh, India, during the rabi season (October to March) of 2023-24 and 2024-25. The experimental site comes under the alluvial zone of the Gangetic plains, having soils with silt loam in texture and low in organic carbon (0.43%) and available nitrogen (185 kg/ha). In addition, the crop was also grown in the Sonebhadra and Deoria districts of Uttar Pradesh.

Raising of the crops

Seeds of Broad bean (cv. Kashi Sampada) were sown in the fine-tilth ridge during the first week of October for the rabi season. The Broad bean seeds were sown at a spacing of 45 x 20 cm (row to row and plant to plant) in a plot size of 10×5 m^2. Five replications were maintained. The recommended doses of N, P, K fertilizers (30:50:40) and FYM 10 to 15 t/ha were applied. N, P and K were supplied through urea, di-ammonium phosphate and muriate of potash, respectively. Half of the nitrogen was applied at the time of sowing as a basal dose and the other half was equally split at the branching stage and at the flower initiation stage. The full doses of both phosphorus and potassium were given at the time of final land preparation. Hand weeding and irrigations were provided as required and usual crop husbandry measures were undertaken except for any plant protection measures.

General surveys

The fields were inspected for signs of insect and mite infestation and insects/mites found feeding on Broad bean were collected and brought to the Biocontrol laboratory of ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh, India and preserved for identification. Information was also recorded on the plant part(s) damaged, the amount and nature of damage, the identity of the fauna, the developmental stage, and the date and area of collection. In addition to these, regular roving surveys with sweep nets (once a week) were also conducted throughout the growth stage to record the beneficial fauna associated with this crop. Together with the field surveys, information on the pest problem was also collected from farmers growing Broad beans in the adjoining districts. Insect specimens were identified at the Crop Protection Division, ICAR-Indian Institute of Vegetable Research, Varanasi, India. In addition, taxonomic help is also being sought from experts from ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, India, and ICAR-Indian Institute of Rice Research, Hyderabad, India.

Results and Discussion

Based on the surveys, all the insect and acarine fauna are being reported on Broad bean for the first time from this region. Also, the utility of the current checklist increases due to the inclusion of detail information on the damaging stage of the insect along with the plant parts infested and the symptoms of damage.

Phytophagous insect and acarine pests

Insect and mite fauna recorded on Broad bean have been listed in Table 1 along with their visible damage symptoms, pest status, taxonomic status, etc. Few species were found to be major pests, while others were of minor pest status under Varanasi, Deoria and Sonebhadra conditions during 2023-24 and 2024-25 (Table 1). The major pests with ≥10% damage were the serpentine leaf miners, *Liriomyza trifolii* (Burgress, 1880); *Liriomyza sativae* Blanchard, 1938 (Agromyzidae: Diptera) and Black bean aphid, *Aphis craccivora* C.L.Koch, 1854 (Aphididae: Homoptera) (Figure 1). The minute orange-yellowish apodous maggots of leaf miner feed on the chlorophyll portion of the leaves in a zig-zag manner, resulting in serpentine white lines appearing on the leaves. Later, these serpentine mines attracted the pathogenic

Table 1: Inventory of insect and acarine pests associated with broad bean

Name	*Taxonomic position*	*Status*	*Plant part(s) affected*	*Stage of the crop and period*	*Nature of damage*
Black bean aphid, *Aphis craccivora* C.L.Koch, 1854	Aphididae: Hemiptera	Major pest	Twigs, apical buds, tender fruits	Both vegetative and reproductive stages (November to March)	This soft-bodied, black coloured sucking pest usually found in colonies on the growing points of the plants, tender fruits, flower buds etc. Both the nymphs and adults suck the sap from the plants and cause stunted growth of the plants and seed shriveling in the developing pods. They also produce honeydew deposited on the plants and develop the black sooty-mould which hinder the photosynthetic activity of the plants.
Bihar hairy caterpillar, *Spilosoma obliqua* (Walker, 1855)	Erebidae: Lepidoptera	Sporadic pest	Leaf	Mostly during vegetative stage of the crop.	Early instars scrap gregariously the chlorophyll mostly on the under surface of the leaves whereas later instars devour the foliage from the margin leaving the mid ribs of the leaves. The leaves of the affected plant give an appearance of net or web
Leaf miner, *Liriomyza trifolii* (Burgress, 1880); *Liriomyza sativae* Blanchard 1938	Agromyzidae: Diptera	Major pest	Leaf	Throughout the crop growth period (October to March)	It is one of the polyphagous agromyzids causing serious damage on several agri-horticultural crops. Damage by the pest occurs due to mining into leaves and petiole by the larvae. The photosynthetic activity of the plants is often greatly reduced. Severely infested leaves may dry and fall.
Yellow tail or swan moth, *Euproctis* sp.	Erebidae: Lepiodptera	Minor pest	Leaf	Throughout the crop growth period (October to March)	Larvae occasionally feed on the leaves of broad bean and defoliate the plant at early vegetative stage.
Tobacco caterpillar, *Spodoptera litura* (Fab.)	Noctuidae: Lepidoptera	Minor pest	Leaf	Foliage feeder during vegetative and reproductive stages	Early instars scrap the chlorophyll portion of the leaves whereas the later instars devour the leaves.
Gram pod borer, *Helicoverpa armigera* (Hübner)	Noctuidae: Lepidoptera	Minor pest	Leaf, apical bud and tender pods	Throughout the crop growth period (October to March)	This highly polyphagous and polymorphous pest infesting more than 400 agricultural and horticultural crops. In broad bean its infestation appears from early vegetative stage onwards. The neonate larvae initially feed on the foliage and later devour the entire leaves leaving the mid ribs. During reproductive stage, it bore that tender pods and feeding its seeds typically thrusting its head inside the pods leaving the rest of its body outside.
Flower thrips, Unidentified	Thysanoptera	Minor pest	Flower and bud	During flowering stage. Damage is more severe during dry period.	Both nymphs and adults feed on the flower and flower buds. In severe infestation flowers may drop prematurely.
Coreid bug, *Cletus* sp.	Coreidae: Hemiptera	Minor pest	Tender pods	Mostly during reproductive stage of the plant.	Through the pod wall, both nymphs and adults sip the sap from the seeds of growing pods. The seeds get shriveled and lose their viability, and the affected pods exhibit obvious brown spots.
Pentatomid bug, *Nezara viridula* (Linnaeus, 1758)	Pentatomidae: Hemiptera	Minor pest	Young shoots, twigs and tender pods	During both vegetative and reproductive stages of the plant.	*N. viridula* may attack all parts of a plant, including the stems and leaf veins, but the feed mostly on fruiting structures and growing shoots. In general, their piercing and sucking mouthparts puncture the plant tissues and form minute, hard, brownish or blackish spots. Feeding caused symptoms like dry shoots, retards the growth of tender pods, fruit drop, black spots on fruit, and reduced yield.
White spotted flea beetle, *Monolepta signata* (Olivier, 1808)	Chrysomelida: Coleoptera	Minor pest	Leaf	Throughout the crop growth period (October to March)	Infestation of adult flea beetles were started from germinating seedling onwards and continued till crop maturity. Initial small minute white dots on the leaves caused by scraping the chlorophyll portion of the leaf by the adults. Small shot holes were then noted in the leaves as a result of their continuous feeding. A bigger shot hole was made by combining numerous smaller ones.
Red spider mite, *Tetranychus* spp.	Tetranychidae: Trombidiformes	Minor pest	Leaf	Both vegetative and reproductive stages particularly during dry period	These mites normally inhabit the under surface of leaves and spin the webs under which both the developing stages and adults damage the crops by sucking the cell sap. Besides, dust particles get adhered to webs and retard normal physiological activities of the plant leading to reduction in plant growth and yield. The affected leaves turn yellow, dry up and finally wither away giving an unhealthy appearance.

fungi and brown zig-zag markings appeared on the leaves. *Liriomyza trifolii*, being polyphagous, was recorded infesting 79 plant species, including vegetables, pulses, oilseeds, green manuring crops, fodder and fibre crops in India (Srinivasan et al., 1995). Parmar et al. (2015) from Gujarat reported that *L. trifolii* is an important insect pest of black gram (*Vigna mungo* (L.)). The black bean aphid, *A. craccivora,* was found to congregate on the young buds, apical shoots and tender fruits. Both nymphs and adults of aphids suck the sap via specially adapted mouthparts from young shoots, apical buds, flowers and flower buds and even from tender fruits, and devitalizing the plants. They are primarily phloem feeders, and secrete sugar-rich honeydew which they deposit on the plant surface and on which black sooty-mould develops and thereby hindering normal photosynthesis (Halder et al., 2011; 2021). *A. craccivora* is an important polyphagous sap-sucking insect that exclusively feeds on the leguminous vegetable crops, including cowpea (*Vigna unguiculata* (Linn.) Walp.), French bean (*Phaseolus vulgaris* Linn.), pea (*Pisum sativum* Linn.), field bean (*Lablab purpureus* (Linn.)), etc. (Ofuya, 1997; Halder et al., 2024(a)). In severe infestation, particularly in the seedling stage, the plants become yellowish, drying and wilting. The defoliator, i.e., Bihar hairy caterpillar *Spilosoma obliqua* (Walker) (Erebidae: Lepidoptera), was sporadic in nature and caused serious damage when it appeared. Other insect pests, *viz*., Tobacco caterpillar, *Spodoptera litura* (Fab.) (Noctuidae: Lepidoptera) (Figure 2); Gram pod borer, *Helicoverpa armigera* (Hübner) (Noctuidae: Lepidoptera) (Figure 3); yellow tail or Swan moth, *Euproctis* sp. (Erebidae: Lepidoptera) (Figure 4); and flower thrips (unidentified) were documented during the observation. The only acarine pest noted during the survey was red spider mite (Table 1). During the onset of spring (end of February to March), when the atmospheric temperature tends to rise, the incidence of red spider mite, *Tetranychus* spp. (Tetranychidae: Trombidiformes) occurred on the lower surface of the mature or semi-mature leaves. In addition to these, two sucking pests, *viz*., *Cletus* sp. (Coreidae: Hemiptera) and *Nezara viridula* (Linnaeus, 1758) (Pentatomidae: Hemiptera) were recorded as a minor pest of faba bean. The nymphs and

Fig. 1: *Aphis craccivora* on apical twig of broad bean

Fig. 2: Fifth instar larva of *Spilosoma obliqua* (Walker) on broad bean

Fig. 3: Fifth instar larva of *Helicoverpa armigera* on broad bean pod

Fig. 4: Larva of *Euproctis* sp. on broad bean leaf

Table 2: Check list of different predatory fauna associated with Broad bean

Name of the insect	*Taxonomic position*	*Beneficial role*
Rove beetle, *Paederus* sp.	Staphylinidae: Coleoptera	Predator on soft-bodied insects like jassids, whitefly nymphs and eggs, aphids, lepidopteran eggs etc.
Lady bird beetle, *Coccinella septempunctata* (Linnaeus, 1758); *Coccinella transversalis* Fabricius, 1781; *Brumoides suturalis* (Fabricius, 1789); *Micraspis discolor* (Fabricius, 1798); *Cheilomenes sexmaculata* Fabricius, 1781	Coccinellidae: Coleoptera	A potential predator on different soft-bodied insects and eggs of lepidopteran insects.
Paper wasp, *Ropalidia* sp.	Vespidae: Hymenoptera	Predator of caterpillars
Preying mantid (Unidentified)	Mantidae: Dictyoptera	Polyphagous; feeds on a wide range of insects *viz*., small moths, grasshoppers and other soft-bodied insects.
Wolf spider (Unidentified)	Lycosidae: Araneae	Polyphagous Predator
Jumping spider (Unidentified)	Salticidae: Araneae	Polyphagous Predator

adults of *Cletus* sp. were found to suck the sap from pods, whereas the latter (*N. viridula*) was found to suck the sap from pods, buds, apical twigs and branches. In a recent study, Nuessly et al. (2004) observed the immature and adults of *N. viridula* suck the sap from pods of faba bean in Southern Florida. The only coleopteran insect pest documented during the survey was the white-spotted flea beetle, *Monolepta signata* (Olivier, 1808) (Figure 5). The adult flea beetles caused damage by their feeding from germinating seedlings onwards and continued till crop maturity. Initial small white dots on the leaves were caused by scraping the chlorophyll portion of the leaf. Small shot holes appeared on the leaves due to their continuous feeding. Later, bigger shot holes were made by combining numerous smaller ones. However, all these insects and acarine pests were minor in nature under Varanasi, Deoria and Sonebhadra districts of eastern Uttar Pradesh.

Predatory fauna

This underutilized leguminous vegetable was found to attract a large number of beneficial fauna during its growth period more especially during its reproductive stage (Table 2). The major predator encountered during the field survey was Lady bird beetles (Coccinellidae: Coleoptera). Interestingly, five lady bird species *viz*., *Coccinella septempunctata* (Linnaeus), *Coccinella transversalis* Fabricius (Figure 6), *Brumoides suturalis* (Fabricius), *Micraspis discolor* (Fabricius) and *Cheilomenes sexmaculata* (Fabricius) (Figure 7) were recorded during the study feeding on various soft-bodied insects. Another predatory beetle *i.e*., rove beetle, *Paederus* sp. (Staphylinidae: Coleoptera) (Table 2) was abundant particularly during the reproductive period. In addition, a few polyphagous praying mantids, long-horned grasshoppers, and wasps were also noticed during the roving survey. The faba bean plants were bushy in nature and large numbers of predatory spider fauna were also recorded to hide in their foliage. Wolf spiders and jumping spiders were the dominant species in this group.

Fig. 5: Adult flea beetle (*Monolepta signata* Olivier) on the broad bean leaf

Fig. 6: *Coccinella transversalis* Fabricius adult on broad bean

Pollinators

Faba bean is a partially allogamous species (self-fertile) with about an equal amount of self and cross-pollination occurring depending on the presence of insect pollinators (Nanda and Bhattacharyya, 2023). In a separate study, Bond

Table 3: Check list of different entomophily fauna associated with Broad bean

Name of the insect	*Taxonomic affiliation*	*Beneficial role*
Honey bee, *Apis dorsata* Fabricius, 1793; *A. cerana indica* (Fabricius, 1798); *A. mellifera* Linnaeus, 1758; *A. florea* Fabricius, 1787	Apidae: Hymenoptera	Pollinate the crops and produces honey and related products.
Chandi beetle, *Epuraea* (*Haptonchus*) *motchulsky* (Reitter, 1873)	Nitidulidae: Coleoptera	Pollinator
Carpenter bee, *Xylocopa sp.*	Apidae: Hymenoptera	Pollinator
Stingless bee / Dammer bee, *Tetragonula iridipennis* Smith, 1854	Apidae: Hymenoptera	Pollinator
Bumble bee, *Bombus* sp.	Apidae: Hymenoptera	Pollinator / Visitor
Syrphid fly (Unidentified)	Syrphidae: Diptera	Pollinator / Visitor

Fig. 7: *Cheilomenes sexmaculata* Fabricius adult on broad bean

and Poulsen (1983) reported an outcrossing of 4–84% in faba bean, whereas Gottschalk (1978) reported the value was 40%. The inflorescences are borne on axillary racemes and they bear between 1 and 6 attractive papilionaceous flowers. These flowers are large (up to 3–4 cm long), white or white with black or dark purple spots on centre. These flowers were found to attract a large number of insects. All four species of honey bees (Apidae: Hymenoptera), *viz*., *Apis dorsata* Fabricius, *A. cerana indica* Fabricius, *A. mellifera* Linnaeus, and *A. florea* Fabricius, were observed as major pollinators on Broad bean (Table 3). The honey bee plays a decisive role in the pollination of allogamous lines (Nanda and Bhattacharyya, 2023). However, their abundance and visiting period were non-synchronized and varied. During the survey, adults of *Epuraea* (*Haptonchus*) *motchulsky* (Nitidulidae: Coleoptera) were seen inside the flowers of broad bean laden with pollens on their elytra, mouth parts, tarsal and antennal segments. This slow moving and fast-flying nitidulid beetles were seen on flowers and flower buds during January-February months. Earlier, the role of *Epuraea* (*Haptonchus*) *motchulsky* was confirmed as a potential pollinator in pointed gourd, *Trichosanthes dioica* Roxb. by Halder *et al*., 2024(b). In addition, a few Carpenters bee, *Xylocopa aestuans* (Apidae: Hymenoptera), Stingless bee or Dammer bee, *Tetragonula iridipennis* (Smith) (Apidae: Hymenoptera) were also recorded during the roving survey (Table 3). Kishan *et al*., 2017 reported that stingless bee *T. iridipennis* is an effective pollinator in greenhouse cucumber in its pollination and increase its fruit weight and yield. *Trigona iridipennis* were shown to be the most important pollinators in crops like onion (*Allium cepa*), sunflower (*Helianthus annuus*), and many agri-horticultural crops in India (Goel & Kumar, 1981; Rao & Suryanarayana, 1989; Sihag, 1985; Heard, 1999).

The present study will envisage the major pests that need to be addressed during the development of eco-friendly pest management modules, as well as steps to be taken for conservation of beneficial fauna, especially predators and pollinators and other natural enemies for sustainable broad bean production in this region.

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सारांश

भारत के पूर्वी उत्तर प्रदेश के वाराणसी, सोनभद्र और देवरिया जिलों के गंगा के मैदानों में 2023–25 के रबी मौसम के दौरान चना (ब्रॉड बीन) में पाए जाने वाले कीट-जीवों का सर्वेक्षण किया गया। इस अध्ययन में सात गणों से संबंधित कीटों को दर्ज किया गया, जो या तो पादपभक्षी गणों जैसे लेपिडोप्टेरा, हेमिप्टेरा, डिप्टेरा, कोलियोप्टेरा और थायसैनोप्टेरा या शिकारी गणों जैसे कोलियोप्टेरा, हाइमेनोप्टेरा और डिप्टेरा के सदस्य पाए गए या हाइमेनोप्टेरा, कोलियोप्टेरा और डिप्टेरा जैसे गणों के परागणकर्ता थे। कीटों में, सर्पेन्टाइन लीफ माइनर (लिरियोमाइज़ा ट्राइफोली और लिरियोमाइज़ा सैटिवे) और ब्लैक बीन एफिड (एफिस क्रैसिवोरा) प्रमुख कीट के रूप में देखे गए क्योंकि उनके द्वारा की गई क्षति 10 प्रतिशत से अधिक थी। बिहार हेयरी कैटरपिलर (स्पिलोसोमा ऑब्लिक्वा) एक बहुभक्षी कीट है और छिटपुट प्रकृति का है। अन्य कीट जैसे तंबाकू कैटरपिलर (स्पोडोप्टेरा लिटुरा), कोरिड बग (क्लेटस प्रजाति), पेंटाटोमिड बग (नेज़ारा विरिडुला), सफेद धब्बेदार पिस्सू भृंग (मोनोलेप्टा सिग्नाटा), लाल मकड़ी का घुन (टेट्रानाइकस प्रजाति) आदि इस शीतकालीन फलियां फसल के लिए गौण प्रकृति के थे। अध्ययन के दौरान, चार शिकारी आर्थ्रोपोडा गण अर्थात (कोलियोप्टेरा, हाइमेनोप्टेरा, डिप्टेरा और एरेनी) और तीन परागणकारी कीट गण (हाइमेनोप्टेरा, कोलियोप्टेरा और डिप्टेरा) का भी दस्तावेजीकरण किया गया। इस प्रकाशन में पहली बार इस क्षेत्र से चना से संबंधित कीटों की सूची बनाई गई है।