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ASSESSMENT OF INSECT INFESTATION AND SPECIES DIVERSITY IN FORAGE SEEDS UNDER STORAGE

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SUMMARY

A two-year study assessed insect infestation and species diversity in stored forage crop seeds in Haryana, India. Seed samples of major forage crops, *viz.*, cowpea, cluster bean and sorghum, were collected from seed stores at CCS Haryana Agricultural University, Hisar and from farmer-saved seed lots in Bhiwani during 2023-24 and 2024-25. The collected seed samples were thoroughly examined for characteristic symptoms of insect infestation, including feeding injury, emergence holes, damaged seeds, frass and the presence of live insects and immature stages. Infested seed samples were processed under laboratory conditions and associated insects were collected and examined under a stereo zoom microscope for taxonomic identification based on external morphological characters with relevant identification keys. The investigation identified five important insect species associated with stored forage seeds, *Callosobruchus maculatus* (Fabricius), *C. chinensis* Linneaus, *Bruchus lentis* Frölich, *Conicobruchus albopubens* (Pic), and *Rhyzopertha dominica* Fabricius. Among them, *C. maculatus* was the most prevalent species. The first documentation of *C. albopubens* in stored cluster bean seed further highlights the need for systematic surveillance of forage seed storage systems to curtail quantitative and qualitative losses and maintain seed quality, germination and viability during storage.

Key words: *Callosobruchus*, *Bruchus*, *Conicobruchus*, taxonomic identification, cluster bean and cowpea

Forage crops such as sorghum, pearl millet, maize, oats, berseem, lucerne, cowpea and cluster bean are primarily grown for fresh forage, silage and hay to meet the nutritional needs of livestock. In India, farmers cultivate seasonal and perennial forage crops to produce green and dry fodder and seeds for cultivation. Based on data from national statistics and FAO, Latin America and the Caribbean have approximately 137 million hectares cultivated with forage crops. South and Southeast Asia with 12 million hectares, and Central-West Asia and North Africa with 6.5 million hectares (Fuglie *et al.*, 2021). Insect-pests and diseases significantly impact these fodder crops both in the field and during storage. Infestations can cause major damage through boring, oviposition, feeding, and development inside the seed, leading to weight loss and reduced seed germination and quality. Storage pests alone can reduce seed germination and vigor by 80 to 100 percent. Additionally, saprophytic fungi like *Aspergillus* and *Penicillium* can cause complete seed mortality, further diminishing the seed's value as planting material. The family Bruchinae is particularly significant among storage insect pests because its larvae develop inside the seeds. Species within the genera *Callosobruchus*, *Bruchus* and *Conicobruchus* primarily infest leguminous seeds used as forage crops. Other primary pests include *Rhyzopertha dominica*, *Corcyra cephalonica*, *Trogoderma granarium*, *Sitotroga cerealella*, etc which also affect the seed quality. Their occurrence in stored cereal seed emphasizes that the pest complex of forage seed storage is not restricted to legume-associated bruchinae beetles.

In Haryana, forage production is closely linked to the development of dairy-based farming systems, particularly in areas where livestock makes a significant contribution to farm income and rural livelihoods. Farmers typically store grains in facilities which are vulnerable to post-harvest losses, and storage insect pests cause substantial damage and economic losses. This undermines farmers' livelihoods and food security. Despite this, a notable gap remains in post-harvest protection research on forage crops in India to address these losses. To address these gaps, the

present study aims to identify the species composition and infestation levels of stored forage seeds in Haryana.

MATERIALS AND METHODS

Sample Collection and Processing: The infested cowpea, sorghum and cluster bean seed samples (100-500 g) were collected from different locations (Seed stores, Forage section, Dept. of Genetics and Plant Breeding, Dept. of Seed Science and Technology, CCSHAU, Hisar and farmer's saved seed samples from Bhiwani district) during 2023 to 2025. The infested samples (80) were then transferred to clean glass jars and maintained under laboratory conditions (28±2!). Thereafter, each sample was examined for the presence of different insects and their stages. Adult specimens were morphologically identified using the taxonomic keys provided by Arora (1979). High-resolution photographs of diagnostic characters were taken using Aven Tools 26800B-339 Micro Stereo ZM 10X-93X W/Light to support accurate identification.

Estimation of insect infestation: The samples collected during the study period were assessed for infestation percentage determined by the ratio of damaged or insect-infested seeds to the total seed count.

Infestation (%) = (Number of infested seeds /Total seeds examined) × 100

Species diversity analysis: The insect community associated with each forage seed type was analyzed using various diversity indices, such as the Shannon-Weiner index, Simpson index, and species richness.

RESULTS AND DISCUSSION

Insect species associated with stored forage seeds: The data presented in Table 1 revealed the occurrence of five insect species belonging to the order Coleoptera, found infesting the seeds, *viz.*, *Callosobruchus maculatus* and *Bruchus lentis* on cowpea, *C. chinensis* on cowpea and cluster bean, *Conicobruchus albopubens* on cluster bean and *Rhyzopertha dominica* on sorghum collected from the different seed stores. A similar study was also carried out by Rashid *et al.* (2023), who also reported five species representing two distinct orders, i.e. Coleoptera (*Callosobruchus maculatus, Tribolium castaneum, Oryzaephilus surinamensis* and *Trogoderma granarium*) and Lepidoptera (*Sitotroga cerealella*).

Similarly, in Jammu and Kashmir region, India, a total of 16 distinct pest species, classified into two orders, namely Coleoptera (81.25%) and Lepidoptera (18.75%), were documented under storage conditions during the years 2017-2018 (Jamwal *et al.*, 2022). Salunkhe and Gaikwad (2025) identified six pulse beetle species, *with C. maculatus*, *C. analis* and *C. chinensis* as the main pests infesting stored legumes such as cowpea, green gram and lentils in Maharashtra. Furthermore, Mehra *et al.* (2025) reported an infestation of *C. albopubens* on Cluster bean seeds from Haryana. *C. albopubens* was reported infesting stored seeds of *C. tetragonaloba* and was also found on *Crotolaria cosmosa* (Arora and Singhal, 1979), as well as on the pods of various *Indigofera* species, including *I. aspera* DC., *I. parviflora* Wight & Arn., *I. senegalensis* Lam. and *I. tinctoria* L.-reared in Senegal (Delobel and Le Rü, 2010).

The bruchid specimens were identified morphologically using taxonomic keys from Arora (1979) and Kingsolver (2004). This included a thorough analysis of species-specific diagnostic morphological traits. All four bruchid species are easily distinguishable by their elytral pubescence patterns and antennal types (Fig.1). The characters identified during the specimen observation include the following:

***i. C. chinensis*:** Male antennae strongly pectinate; hind femur bicarinate and toothed; elytra with distinct white pubescent markings.

TABLE 1
Insect species associated with different host

S. No.	Insect species	Family	Order	Host
1.	*Callosobruchus maculatus*	Chrysomelidae	Coleoptera	Cowpea
2.	*C. chinensis*	Chrysomelidae	Coleoptera	Cowpea, Cluster bean
3.	*Bruchus lentis*	Chrysomelidae	Coleoptera	Cowpea
4.	*Conicobruchus albopubens*	Chrysomelidae	Coleoptera	Cluster bean
5.	*Rhyzopertha dominica*	Bostrychidae	Coleoptera	Sorghum

ii. C. maculatus: Antennae serrate; hind femur bicarinate with teeth; elytra show characteristic dark pubescent pattern.

iii. B. lentis: Dark body with characteristic pale pubescent markings on elytra and pygidium; antennae short

***C. albopubens*:** Black metallic body densely covered with white pubescence; antennae short and bicoloured; hind femur slender.

Furthermore, the diagnostic features of *R. dominica* were also observed. Key characteristics include a small, cylindrical, dark brown body, with a deflexed head mostly hidden beneath the pronotum. The pronotum round at the front and has teeth on the anterior margin. The elytra are distinctly striated and broadly rounded at the posterior end (Fig.1). Similarly, Southgate (1979) described key morphological traits, like metatibial carination and elytral setal patterns, for the systematic classification of important genera such as *Callosobruchus*, *Bruchidius*, *Acanthoscelides* and *Zabrotes*.

Estimation of insect infestation:

During 2023-24 to 2024-25, a total of 80 seed samples were collected from three locations and examined for insect infestation. Infestation was observed in three crops: cowpea, cluster bean and sorghum, with notable differences in infestation levels among them. Cowpea showed the highest infestation at 53.8%, caused by three bruchid species: *C. maculatus*, *C. chinensis* and *B. lentis*. Moreover, Sorghum seed recorded 24.6% infestation, mainly due to *R. dominica*. However, cluster bean seeds had a lower infestation at 8.0%, with *C. chinensis* and *C. albopubens* (Table 2). Likewise, Rashid *et al.* (2023) reported the maximum infestation (26.98%) and weight loss (28.91%) of cowpea among the surveyed areas.

Similarly, Srinivasan *et al.* (2008) observed *C. maculatus* as a major pest of stored cowpea seeds in Dharwad district, Karnataka. Similarly, Hampanna *et al.* (2006) reported it in Raichur district, Karnataka. Tamgno and Ngamo (2013) noted that *C. maculatus* was the most prominent pest infesting cowpeas (34.92 bruchids per gram of seed) under storage conditions in Central Africa. However, Aidbhavi *et al.* (2023) found that under large-scale storage conditions, samples infested with *C. chinensis* experienced the highest grain damage (10.9 ± 4.3%) followed by *C. analis* (9.9 ± 3.6%) and *C. maculatus* (8.4 ± 3.7%).

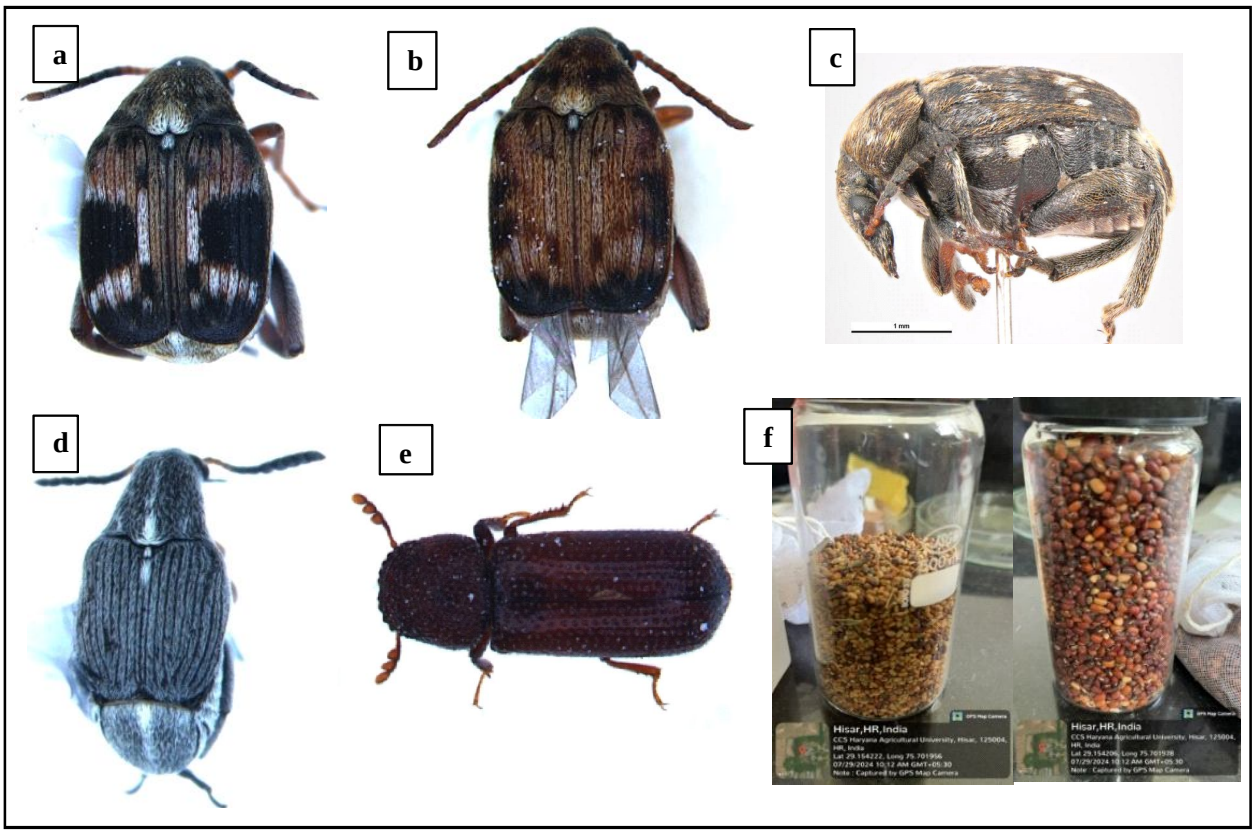


Fig. 1. Dorsal habitus: a) *Callosobruchus maculatus*, b) *C. chinensis*, c) *Bruchus lentis* (Lateral), d) *Conicobruchus albopubens*, e) *Rhyzopertha dominica* and f) infested sample collection.

TABLE 2
Insect infestation level of different host seeds collected during the study period

S. No.	Host	Major insect pest(s) recorded	Overall Infestation (%)
1.	Cowpea	*Callosobruchus maculatus, C. chinensis, Bruchus lentis*	**53.8**
2.	Cluster bean	*C. chinensis, Conicobruchus albopubens*	**8.0**
3.	Sorghum	*Rhyzopertha dominica*	**24.6**

TABLE 3
Estimation of relative abundance and diversity indices of stored insect pests

S. No.	Species	No. of individuals (n)	Relative abundance (%)	Shannon index (H2)	Simpson dominance (D)	Simpson diversity (1-D)	Margalef richness (R)
1	*Callosobruchus maculatus*	44	30.56	-	-	-	-
2	*Callosobruchus chinensis*	38	26.39	-	-	-	-
3	*Bruchus lentis*	18	12.50	-	-	-	-
4	*Conicobruchus albopubens*	12	8.33	-	-	-	-0
5	*Rhyzopertha dominica*	32	22.22	-	-	-	-
Total	5	144	100.00	1.515	0.235	0.765	0.805

Analysis of species diversity indices:

As shown in Table 3, 144 individuals representing five insect-pest species were recorded from infested seed samples. *C. maculatus* was the most abundant species, with 44 individuals (30.56%), followed by *C. chinensis* with 38 individuals (26.39%), *R. dominica* with 32 individuals (22.22%), *B. lentis* with 18 individuals (12.50%), and *C. albopubens* with 12 individuals (8.33%). Similar results were recorded by Rashid *et al.* (2023) on cowpea where *C. maculatus* (53.60%) was the most abundant species followed by *T. castaneum* (18.60%), *S. cerealella* (16.97%), *Oryzeaphilus surinamensis* (6.49%) and *T. granarium* (04.34%). Likewise, Credland and Wright (1990) reported that *C. maculatus* causes losses of 60-100%, either qualitative or quantitative, over a six-month storage period.

The insect species diversity was calculated by the Shannon index (H2) value of 1.515, representing moderate diversity with varying abundance across the five insect species. The Simpson dominance index (D) was 0.235, and the Simpson diversity index (1-D) was 0.765, indicating moderate diversity and low dominance by any single species reported. The Margalef richness index (R) value is 0.805, which reflects the diversity of species within the sampled insect community. Similarly, Aidbhavi *et al.* (2023) noted that the overall species diversity index value 1.1, with an effective number of species of 3. *C. maculatus* emerged as the most abundant and dominant species in small-scale storage, while *C. analis* was predominant in large-scale storage conditions. Small-scale storages exhibited higher diversity and richness, whereas large-scale storages showed greater evenness. Madhya Pradesh, Andhra Pradesh, and Uttar Pradesh recorded higher diversity indices, while West Bengal and Tamil Nadu had lower index values. The highest diversity indices were observed in crops such as chickpea (desi and kabuli) and field pea.

CONCLUSION

The present study reported five Coleopteran insect species infesting forage seeds: *Callosobruchus maculatus* and *Bruchus lentis* on cowpea, *C. chinensis* on cowpea and cluster bean, *Conicobruchus albopubens* on cluster bean, and *Rhyzopertha dominica* on sorghum from various locations. Cowpea had the highest infestation (53.8%), followed by sorghum (24.6%) and cluster bean (8.0%). Among all insect species, *C. maculatus* was the most abundant, followed by *C. chinensis*, *R. dominica*, *B. lentis* and *C. albopubens*. These findings support pest-control strategies to minimize the infestations and promote more sustainable, resilient farming through improved seed quality.

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