Research Article

Developmental Biology, Feeding Preference, and Botanical Management of the Lesser Grain Borer (*Rhyzopertha dominica*) in Millets

Sreehari Pelluri*, Mariadoss Arulanandam
Vertebrate Pest Management, NIPHM, Hyderabad, India
Email: sreehari.pelluri@gmail.com

During storage, either at household, rural, or trader level, commodities are attacked by several species of insect pests, including *Rhyzopertha dominica*, *Sitophilus oryzae*, *Tribolium castaneum*, and *Sitotroga cerealella*, resulting in losses in both quantity and quality. Major losses of food grains during storage are mainly due to insect pests, among which internal feeders such as the lesser grain borer, *Rhyzopertha dominica*, are considered to be of prime importance. *Rhyzopertha dominica* is a major pest of rice, wheat, and millets such as sorghum, pearl millet, and proso millet.

Research on stored millets has mainly focused on the susceptibility of different cultivars to insect pest damage, physico–chemical changes in the produce due to infestation, and the germinability of infested grains. However, studies on developmental biology and feeding preference in millets, particularly on *Rhyzopertha dominica*, are rather limited. Moreover, with the growing demand for pesticide-free commodities, botanical management has become an inevitable practice.

In wheat, rice, maize, sorghum, and other millets, the effects of infestation by *Rhyzopertha dominica* at different growth stages on nutritional properties, dough rheological properties, food processing properties, and other relevant quality indices were evaluated. Infestation was carried out at the egg, larval, pupal, and adult stages under optimal growth conditions of temperature (32 ± 1)°C and relative humidity of 75 ± 1%.

Keywords: Vertebartes, Feeding, Pest Control, Millets, Borer, *Rhyzopertha dominica*

Introduction

Millets are a collective term referring to a group of small-seeded annual grasses cultivated as grain crops, primarily on marginal lands in dry areas of temperate, subtropical, and tropical regions. These crops are mainly grown in developing countries as subsistence crops for local consumption.

India is the largest producer of millets in the world, and the year 2023 was declared by the United Nations as the International Year of Millets following a proposal by India, with the aim of positioning the country as a global hub for millet production. Major millet crops grown in India include pearl millet, foxtail millet (*Setaria italica*), little millet (*Panicum sumatrense*), kodo millet (*Paspalum scrobiculatum*), barnyard millet *Echinochloa* spp., proso millet (*Panicum miliaceum*), sorghum (*Sorghum bicolor*), and finger millet (*Eleusine coracana*). Pseudo-millets such as buckwheat and amaranths are also widely cultivated. Pearl millet, sorghum, and finger millet together constitute the largest share of India's total millet production.

The production of pearl millet has shown a steady increase, while finger millet remains an important crop in states such as Karnataka and Tamil Nadu. Andhra Pradesh, Odisha, Bihar, and Maharashtra are also among the major millet-growing states. India's two major millets, pearl millet and sorghum, together contributed approximately 19% of the global millet production in 2020. Pearl millet alone accounted for 40.51% of the world's millet production, followed by sorghum at 8.09% (APEDA, 2023).

During storage, whether at the household, urban, rural, or trader levels, stored commodities are attacked by several species of insect pests, including *Rhyzopertha dominica*, *Sitophilus oryzae*, *Tribolium castaneum*, and *Sitotroga cerealella*, resulting in considerable losses in both quantity and quality (Mahanti, 2002; Park et al., 2015). Among these pests, internal feeders such as the lesser grain borer, *Rhyzopertha dominica*, are considered to be of prime importance (Fisher, 1950; Kumar et al., 2021). *Rhyzopertha dominica* is the major pest of rice, wheat, and several millets, including sorghum, pearl millet, and proso millet (Kishore, 1993).

Research on stored millets has largely focused on the susceptibility of different cultivars to insect pest damage, physico–chemical changes in the produce due to infestation, and the germinability of infested grains (Kishore, 1993). However, studies addressing the developmental biology and feeding preference of *Rhyzopertha dominica* on millets are relatively limited. Furthermore, the increasing demand for pesticide-free commodities has made the exploration of botanical management practices an inevitable and necessary approach for the sustainable management of storage pests (Isman, 2006; Saxena et al., 1976).

The geographical origin of *Rhyzopertha dominica* remains uncertain; however, the Indian subcontinent is considered its most probable native region, as it harbours several other species belonging to the family Bostrichidae (Park et al., 2015). At present, *Rhyzopertha dominica* is widely distributed throughout the world, particularly in warmer temperate regions between 40° North and South of the equator. The pest is commonly associated with forested habitats and grain storage environments. Human activities, especially the commercial transportation of grains, have played a significant role in its widespread distribution (Mahanti, 2002). Its close association with stored wheat has led to its common designation as the "Australian wheat weevil," reflecting its severe infestation of wheat in Australia (Bayer, n.d.).

Considering the economic importance of millets, the destructive nature of the lesser grain borer in stored grains, the limited information available on its developmental biology and feeding preference on millets, and the growing emphasis on pesticide-free storage management, the present study was undertaken to examine the occurrence of *Rhyzopertha dominica* in stored millets, to understand its developmental biology and feeding preference on different millets, and to evaluate the efficacy of locally available botanicals against the

Published online: 01 February 2026

pest under *in vitro* conditions (Arya & Tiwari, 2013; Valand et al., 1993; Rahim, 1998; Sharma et al., 2010).

Materials and Methods

The present investigation was conducted during 2023 at the Laboratory of Stored Grain Pests, National Institute of Plant Health Management (NIPHM), Rajendranagar, Hyderabad. Different types of millets used in the study were procured from the Indian Institute of Millet Research (IIMR), Rajendranagar, Hyderabad. The millets selected for experimentation included sorghum, pearl millet (bajra), little millet, kodo millet, foxtail millet, barnyard millet, and browntop millet. The millets had undergone approximately six months of storage prior to experimentation.

For studies on developmental biology, 450 g of each millet was used with three replications, whereas sorghum seeds (2 kg) were used for evaluating botanical treatments. Plastic containers with perforated lids or muslin cloth covers secured with rubber bands were used for insect rearing and experimentation. Additional materials included transplant plastic jars, insect breeding dishes, brushes, tubs, sieves, and a hand microscope. A glass funnel was used for releasing insects during feeding preference studies.

Other materials used included sketch pens, white cotton cloth, rubber bands, and a mechanical grinder for preparing botanical powders. Fresh leaves of neem (*Azadirachta indica*), pungam (*Millettia pinnata*), jamun (*Syzygium cumini*), custard apple (*Annona squamosa*), and castor (*Ricinus communis*) were used as botanical treatments.

Identification of *Rhyzopertha dominica*

The lesser grain borer, *Rhyzopertha dominica*, was identified based on visual examination of larval and adult stages using a hand lens and compound microscope. Grain samples were sieved to detect the presence of adults and externally feeding larvae. Larvae were white to cream coloured, possessed biting mouthparts, and had three pairs of legs. Early instar larvae were mobile within the grain bulk, while later instars became immobile and assumed a characteristic C-shaped form as development progressed within the grain.

Adults measured approximately 2–3 mm in length, were reddish-brown in colour, and exhibited a cylindrical body shape. The elytra showed regular rows of coarse punctures covered with curved setae, while the pronotum displayed a distinct saw-toothed anterior margin. The head was not visible when viewed dorsally, and the antennae terminated in a characteristic three-segmented club.

Developmental biology of *Rhyzopertha dominica* on millets

To study the developmental biology of *Rhyzopertha dominica* on different millets, 150 g of each millet variety was placed in separate plastic containers and covered with perforated lids or muslin cloth to ensure adequate aeration. Each treatment was replicated three times. Twenty freshly emerged adults were released into each container and maintained under ambient laboratory temperature and relative humidity.

Observations on larval and adult populations were recorded at 15, 30, 45, 75, and 90 days after release (DAR). Adults were removed one week after initial release to prevent overlapping generations.

Feeding preference of *Rhyzopertha dominica* towards millets

Feeding preference studies were conducted using a choice test method. Ten grams of each millet sample were placed equidistantly within a plastic tub and covered with cotton cloth. One hundred newly emerged adults of *Rhyzopertha dominica* were released into the center of the setup through a glass funnel. The experimental setup was left undisturbed for 24 hours to allow the insects to select their preferred millet type. After the exposure period, the number of adults present in each millet sample was counted and recorded, and feeding preference was assessed based on adult distribution.

Figure 1: Feeding preference of *Rhyzopertha dominica* in different millets at different days after release

Evaluation of botanicals against *Rhyzopertha dominica* under *in vitro* conditions

Locally available botanicals, namely neem (*Azadirachta indica*), pungam (*Millettia pinnata*), jamun (*Syzygium cumini*), custard apple (*Annona squamosa*), and castor (*Ricinus communis*), were collected from the NIPHM campus and nearby areas.The plant materials were washed thoroughly with fresh water to remove dust, fungi, and insects, shade-dried, and ground using a mechanical grinder. The powdered material was sieved through a suitable mesh and stored in plastic containers until use.

For bioassay studies, 50 g of sorghum seeds were placed in each insect breeding dish. Botanical powders were mixed thoroughly with the seeds at two dosage levels, 3 g and 5 g. Each treatment was replicated three times. Observations on insect activity were recorded at 3, 5, and 15 days after treatment. The collected data were subjected to suitable transformation prior to analysis.

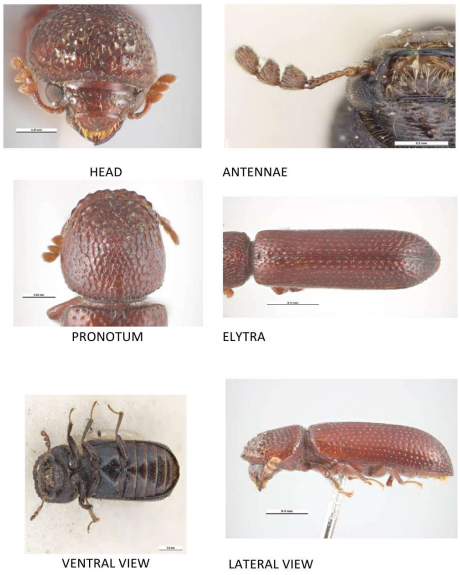

Figure 2: *Rhyzopertha dominca* different positional views

Results

Study of developmental biology of *Rhyzopertha dominica* in different types of millets

The study was conducted at the Laboratory of Stored Grain Pests, National Insti-

Published online: 01 February 2026

tute of Plant Health Management, Hyderabad, during the year 2023. Seven types of millets, namely sorghum, bajra, little millet, kodo millet, foxtail millet, barnyard millet, and browntop millet, were used in the study.

The number of grubs that emerged in different millets was sorghum (24.33), bajra (22.0), little millet (3.67), kodo millet (4.33), foxtail millet (6.67), barnyard millet (2.67), and browntop millet (10.33), respectively.

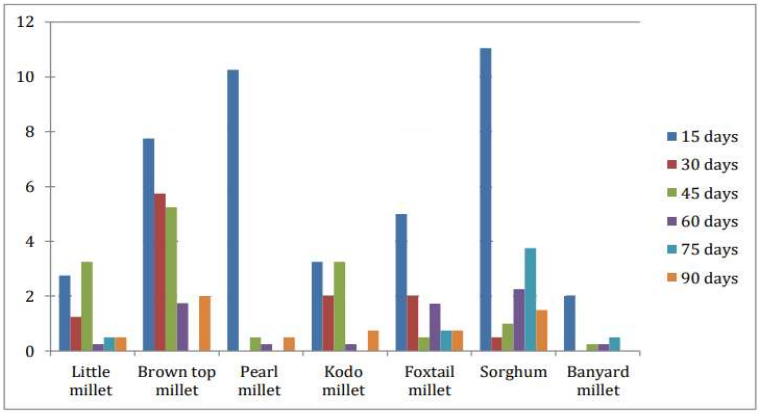

Figure 1: Average of Larva development in different millet

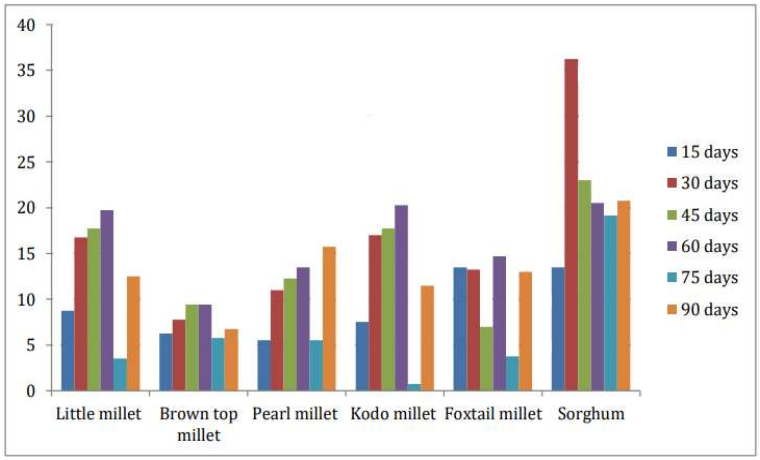

Figure 2: Average of adult development biology on different types of millets

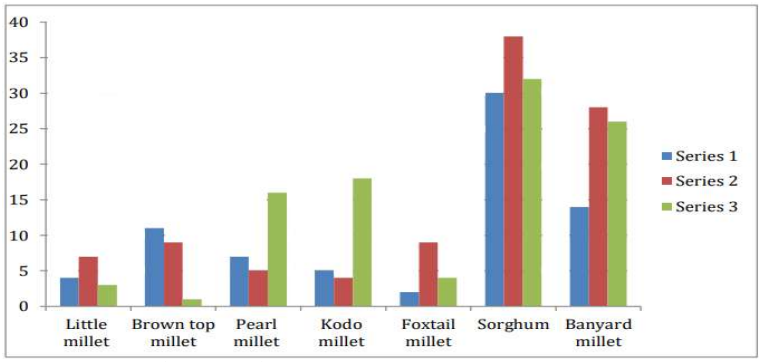

Figure 3: Feeding preference of *Rhyzopertha dominica* in different types of millets at different days after release

The development of larvae of *Rhyzopertha dominica* during the first fifteen days after release days after release(DAR) was recorded in different types of millets.

Significantly higher numbers of grubs were observed in sorghum and pearl millet. The highest grub emergence was recorded in sorghum (24.33) followed by pearl millet (22.0) at 15 DAR.

With reference to adult development, a significantly higher number of *Rhyzopertha dominica* adults developed in sorghum (13.5), foxtail millet (13.5), little millet (8.75), kodo millet (7.5), browntop millet (6.25), pearl millet (5.5), and barnyard millet (0) at 15 DAR. The significantly highest adult population count was recorded in sorghum and foxtail millet.

The second observation was recorded at 30 DAR. Larval development was observed in little millet (1.25), browntop millet (5.75), pearl millet (5), kodo millet (2), foxtail millet (2), sorghum (1), and barnyard millet (0). In this observation, larvae emerged at different time durations between 25 and 30 DAR.

Adult populations increased in comparison to the first observation. Adult emergence at 30 DAR was recorded in little millet (16.75), browntop millet (7.75), pearl millet (11), kodo millet (17.0), foxtail millet (13.25), sorghum (36.25), and barnyard millet (1).

Observations recorded at 45 DAR showed larval development in little millet (3.25), browntop millet (5.25), pearl millet (0.5), kodo millet (3.25), foxtail millet (0.5), sorghum (1), and barnyard millet (0.25). Adult emergence at 45 DAR was well developed in little millet (17.75), browntop millet (9.5), pearl millet (12.25), kodo millet (17.75), foxtail millet (7), sorghum (23), and barnyard millet (1.5).

At 60 DAR, larval development was higher in sorghum (2.25), foxtail millet (1.75), and browntop millet (1.75), while lower larval development was observed in barnyard millet, pearl millet, little millet, and kodo millet (0.2). Adult development at 60 DAR was well established in little millet (19.75), browntop millet (9.5), pearl millet (13.50), kodo millet (20.25), foxtail millet (14.75), sorghum (20.25), and barnyard millet (0.25).

At 75 DAR, larval development was lower compared to previous observations, with higher values recorded in sorghum (3.75), followed by foxtail millet (0.75), little millet (0.5), and barnyard millet (0.5). No larval development was observed in pearl millet, kodo millet, and browntop millet (0). Adult development at 75 DAR was highest in sorghum (19.25), followed by little millet (3.5), browntop millet (5.75), pearl millet (5.5), kodo millet (0.75), foxtail millet (3.75), and barnyard millet (4.75).

At 90 DAR, larval development was observed in sorghum (1.5), little millet (0.5), browntop millet (2), pearl millet (0.5), kodo millet (0.75), foxtail millet (0.75),

Published online: 01 February 2026

and barnyard millet (0). Adult populations at 90 DAR were highest in sorghum (20.75) and pearl millet (15.75), followed by little millet (12.5), foxtail millet (13), kodo millet (11.05), browntop millet (6.75), and barnyard millet (3).

Locally available botanicals against *Rhyzopertha dominica*

The bioefficacy of different botanicals against adults of *Rhyzopertha dominica* at different storage periods was recorded. It was evident from the data that the mortality of *R. dominica* adults was significantly influenced by different plant powders. After 3 days of treatment, neem (*Azadirachta indica*) at @3 g/@50 g of sorghum seed (96.0) and @5 g/@50 g of seed (97.67); pungam (*Millettia pinnata*) at @3 g/@50 g of sorghum seed (96) and @5 g/@50 g (99.33); jamun (*Syzygium cumini*) at @3 g/@50 g of sorghum seed (98.67) and @5 g/@50 g (99.33); custard apple (*Annona squamosa*) at @3 g/@50 g of sorghum seed (99) and @5 g/@50 g (99); and castor (*Ricinus communis*) at @3 g/@50 g of sorghum seed (98.67) and @5 g/@50 g (99.67) recorded high adult mortality. Observations recorded at 15, 30, and 45 days after treatment are presented in Table 2.

Discussion

The present study demonstrates clear host-dependent differences in the development and population build-up of *Rhyzopertha dominica* on different millet types, with sorghum and pearl millet supporting significantly higher larval emergence and adult populations compared to other millets. Similar patterns have been reported in recent experimental studies evaluating *Rhyzopertha dominica* development on sorghum and millet grains, where sorghum consistently supported faster development, higher progeny emergence, and sustained adult populations under storage conditions (Agrafioti et al., 2023; Singh et al., 2023). The comparatively lower infestation levels observed in barnyard millet, little millet, and kodo millet in the present investigation are consistent with recent findings indicating that several small millets exhibit reduced susceptibility to internal feeders, possibly due to compact grain structure and biochemical deterrents (Rao et al., 2024).

The higher grub emergence recorded at early storage intervals and the sustained adult dominance observed at later stages in sorghum suggest that this grain provides a nutritionally and structurally favourable environment for borers. Recent studies have emphasized that kernel hardness, starch availability, lipid content, and endosperm characteristics strongly influence host suitability for internal feeding pests, including *Rhyzopertha dominica* (Kumar et al., 2023; Kavallieratos et al., 2024). In contrast, minor millets such as barnyard and kodo millet have been reported to contain higher levels of phenolic compounds and anti-nutritional factors, which may interfere with larval feeding

Table 1: Developmental biology of larva and adult of *Rhyzopertha dominica* on different millets

Sample (150 g)	Days after release (DAR)											
	15		30		45		60		75		90	
	Larva	Adult	Larva	Adult	Larva	Adult	Larva	Adult	Larva	Adult	Larva	Adult
Little millet	2.75	8.75	1.25	16.75	3.25	17.75	0.25	19.75	0.5	3.5	0.5	12.5
Brown top millet	7.75	6.25	5.75	7.75	5.25	9.5	1.75	9.5	0	5.75	2	6.75
Pearl millet	10.25	5.50	0.00	11.00	0.5	12.25	0.25	13.5	0	5.5	0.5	15.75
Kodo millet	3.25	7.50	2.00	17.00	3.25	17.75	0.25	20.25	0	0.75	0.75	11.5
Foxtail millet	5.00	13.50	2.00	13.25	0.5	7	1.75	14.75	0.75	3.75	0.75	13
Sorghum	11.05	13.50	0.50	36.25	1	23	2.25	20.5	3.75	19.25	1.5	20.75
Barnyard millet	2.00	0.00	0.00	1.00	0.25	1.5	0.25	1.75	0.5	4.75	0	3
SEm ±	3.427	8.006	2.112	5.119	2.093	5.071	0.926	6.015	0.943	4.513	1.113	3.142
CD (5%)	10.395	24.284	6.406	15.528	6.349	15.381	2.808	18.243	2.860	13.688	3.375	9.531

Table 2: Effect of locally available botanicals against adults of *Rhyzopertha dominica*

Treatments	3 days	15 days	30 days	45 days
T1: Neem leaf extract @3 gm	4.00	0.33	0.00	0.00
T2: Neem leaf extract @5 gm	2.33	0.67	0.33	0.33
T3: Pungam leaf extract @3 gm	4.00	2.33	1.33	0.33
T4: Pungam leaf extract @5 gm	0.67	0.33	0.00	0.00
T5: Jamun leaf extract @3 gm	1.33	0.67	0.33	0.33
T6: Jamun leaf extract @5 gm	0.67	0.00	0.00	0.00
T7: Castor leaf extract @3 gm	1.33	0.00	0.00	0.00
T8: Castor leaf extract @5 gm	0.33	0.33	0.00	0.00
T9: Custard apple leaf extract @3 gm	1.00	1.00	0.67	0.00
T10: Custard apple leaf extract @5 gm	1.00	0.33	0.67	0.00
T11: Untreated control	19.00	18.33	17.33	17.00
SEm ±	0.835	0.482	0.389	0.246
CD (5%)	2.449	1.414	1.142	0.722

Table 3: Feeding preference of *Rhyzopertha dominica* on different millets

150 g	R1	R2	R3	Mean
Little	4.00	7.00	3.00	3.50
Brown top	11.00	9.00	1.00	5.25
Pearl	7.00	5.00	16.00	7.00
Kodo	5.00	4.00	18.00	6.75
Foxtail	2.00	9.00	4.00	3.75
Sorghum	30.00	38.00	32.00	25.00
Barnyard	14.00	28.00	26.00	17.00
SEm	Nil	Nil	Nil	3.202
CD (5%)	Nil	Nil	Nil	9.713

Published online: 01 February 2026

efficiency and slow population growth, thereby explaining the lower larval and adult counts observed in these grains (Rao et al., 2024; Kumar et al 2023).

The progressive increase in adult populations up to 60–90 days after release observed in the present study further indicates the ability of *Rhyzopertha dominica* to establish overlapping generations during storage. Recent population ecology studies have shown that under favourable temperature and humidity conditions, internal feeders such as *Rhyzopertha dominica* rapidly complete development and adult populations dominate later storage periods, even when larval counts appear reduced due to successful adult emergence (Mutambuki et al., 2024; Nayak & Daglish, 2023). This population pattern underscores the importance of early detection and timely management interventions to prevent exponential population build-up during prolonged storage. The preferential development and feeding of *R. dominica* on sorghum and pearl millet observed in the present investigation have important implications for millet storage management. Recent literature increasingly supports grain-specific risk assessment and host-based management approaches as key components of sustainable stored-product pest management strategies (Phillips et al., 2023; Nayak et al., 2025). The relatively lower susceptibility of barnyard millet and little millet suggests their suitability for longer storage durations with reduced pest risk, aligning with current global efforts to promote eco-friendly, low-pesticide post-harvest management systems. Overall, the findings of the present study are in agreement with recent reports and contribute to the growing body of evidence highlighting the role of host grain characteristics in determining the developmental success and population dynamics of *Rhyzopertha dominica* in stored millets.

Conclusion

The present study confirms that *Rhyzopertha dominica* is one of the most serious and destructive primary pests of stored grains. Identification of *Rhyzopertha dominica* in stored millets through visual inspection and microscopic examination proved to be effective. The adult beetles were reddish-brown in colour with a cylindrical body shape and sluggish movement, while the larvae were white to cream coloured, possessing biting mouthparts, three pairs of legs, and a characteristic C-shaped body. *Rhyzopertha dominica* primarily infests cereal grains such as maize, wheat, rice, and other stored grains, where its feeding activity results in the formation of powdery residues, leading to considerable losses in both quality and quantity of the stored commodity. The pest was found to thrive under storage conditions, with temperatures ranging from 27–34°C being optimal for its growth and development.

Among the millets evaluated, namely little millet, browntop millet, pearl millet, kodomillet, foxtail millet, sorghum, and barnyard millet, sorghum, pearl millet, and barnyard millet supported faster larval and adult development, indicating higher susceptibility compared to the other millets. Feeding preference studies further supported these observations, as adult *Rhyzopertha dominica* showed a marked preference for sorghum, followed by barnyard millet and pearl millet, in comparison with other millet types.

The evaluation of locally available botanicals revealed that plant powders of jamun, custard apple, and neem were highly effective against *Rhyzopertha dominica* adults when applied to sorghum seeds at both 3 g and 5 g per 50 g of seed. These botanicals caused high mortality within a shorter time period compared to pungam and castor. The findings of the present study highlight the potential of botanical powders as effective, eco-friendly alternatives for the management of *Rhyzopertha dominica* in stored millets.

Received: 10 January 2025 **Revised:** **Accepted:** 19 January 2026 **Published:** 31 January 2026

References

Kumar, A., Tripathi, M. K., Joshi, D., & Kumar, V. (Eds.). (2021). *Millets and Millet Technology*. Springer Singapore. https://doi.org/10.1007/978-981-16-0676-2

APEDA. (n.d.). Production introduction of millets [Internet]. Available from: https://apeda.gov.in/milletportal/Production_introduction_of_millets.html

Achary, V. M. M., Reddy, C. S., Pandey, P., Islam, T., Kaul, T., & Reddy, M. K. (2015). Glutathione reductase, a unique enzyme: molecular cloning, expression, and biochemical characterization from the stress-adapted C4 plant *Pennisetum glaucum* (L.) R. Br. *Molecular Biology Reports*, 42(5), 947–962. https://doi.org/10.1007/s11033-014-3832-z

Arya, M., & Tiwari, R. (2013). Efficacy of plant- and animal-origin bio-products against lesser grain borer, *Rhyzopertha dominica* (Fab.) in stored wheat. *International Journal of Recent Scientific Research*, 4, 649–653.

Fisher, W. S. (1950). *Rhyzopertha dominica* (Fabricius). In *Revision of the North American Species of Beetles Belonging to the Family Bostrichidae*. United States Department of Agriculture, Miscellaneous Publications, Vol. 698. Washington, DC: U.S. Government Printing Office. https://doi.org/10.5962/bhl.title.65663

Isman, M. B. (2006). Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annual Review of Entomology*, 51, 45–66. https://doi.org/10.1146/annurev.ento.51.110104.151146

Kishore, P. (1993). Relative susceptibility of pearl millet varieties and hybrids to *Tribolium castaneum* Herbst., *Sitophilus oryzae* Linn., and *Rhyzopertha dominica* Fab. in storage. *Journal of Entomological Research*, 17(2), 153–154.

Valand, K. P., Patel, V. M., & Patel, S. N. (1993). Powder of neem seed kernel for control of lesser grain borer (*Rhyzopertha dominica*) in wheat (*Triticum aestivum*). *Indian Journal of Agricultural Sciences*, 63, 754–755.

Kalasagond, P. R. (1998). *Management of beetle pests in stored wheat by non-insecticidal approaches*. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Kumawat, K. C. (2009). Efficacy of plant powders against lesser grain borer, *Rhyzopertha dominica* (Fabricius) in stored wheat (*Triticum aestivum* Linnaeus). *Journal of Insect Science*, 22, 448–452.

Lingappa, L. G., & Venugopal, M. S. (2007). Effectiveness of powdered plant products as grain protectants against the pulse beetle, *Callosobruchus maculatus* (F.). *Journal of Entomological Research*, 31, 75–78.

Mahanti, V. (2002). *Ecology and management of stored grain pests of maize*. Ph.D. Thesis, N. G. Ranga Agricultural University, Hyderabad.

Park, S., Lee, S., & Hong, K.-J. (2015). Review of the family Bostrichidae (Coleoptera) of Korea. *Journal of Asia-Pacific Biodiversity*, 8(4), 298–304. https://doi.org/10.1016/j.japb.2015.10.012

Rahim, M. (1998). Biological activity of azadirachtin-enriched neem kernel extracts against *Rhyzopertha dominica* (F.) (Coleoptera: Bostrichidae) in stored wheat.

Published online: 01 February 2026

34, 123–128. https://doi.org/10.1016/S0022-474X(97)00037-X

Savitri, P., & Subba Rao, C. (1976). Studies on the admixture of neem seed kernel powder with paddy in the control of important storage pests of paddy. *Andhra Agricultural Journal*, 23, 137–142.

Saxena, B. P., Koul, O., & Tikku, K. (1976). Non-toxic grain protectants against stored grain insects. *Bulletin of Grain Technology*, 14, 190.

Sharma, K. C., Jain, N. K., Mishra, B. K., & Kumar, S. (2010). Bio-efficacy of plant products of custard apple (*Annona squamosa* L.). *Indian Journal of Applied Entomology*, 24, 54–57.

Bayer Crop Science. (n.d.). Lesser grain borer (*Rhyzopertha dominica*): Management of storage pests [Internet]. Available from: https://cropscience.bayer.co.uk/agronomy-id/pest-and-slugs/lesser-grain-borer

Published online: 01 February 2026