Plant Archives Vol. 25, No. 1, 2025 pp. 1493-1497 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.220

INSECT INFESTATION AND QUANTITATIVE LOSSES IN STORED CEREALS PULSES AND DRY FRUITS

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(Date of Receiving-04-02-2025; Date of Acceptance-12-04-2025)

ABSTRACT

The progressive damage caused by major storage insect pests across cereals (rice, sorghum, maize, wheat), pulses (chickpea, cowpea, pigeon pea, green gram), and dry fruits (cashew, raisins) under controlled conditions. Over 90 days of storage, *Callosobruchus maculatus* inflicted catastrophic damage to pulses, with cowpea experiencing 97.10% seed damage and 9.34% weight loss, the highest among all commodities. Cereals showed substantial but comparatively lower susceptibility, with *Sitophilus oryzae* causing 80.42% damage in sorghum and 74.84% in wheat. Dry fruits exhibited measurable losses, with *Corcyra cephalonica* accounting for 6.68% weight loss in cashew and 5.91% in raisins, while *Oryzaephilus surinamensis* caused 3.33–3.61% damage. Damage progression followed a nonlinear trajectory, with pulses exceeding 50% loss by 60 days, compared to 90 days for cereals, highlighting their acute vulnerability.

Key words: Storage pests, Grain damage, Postharvest losses, Pest management

Introduction

Human efforts to store agricultural produce date back 4,500 years (Levinson & Levinson, 1985), yet post-harvest losses remain a critical challenge, particularly in developing regions where traditional storage methods persist. Globally, nearly one-third of food is lost annually, with storage pests causing significant damage (FAO, 2021). In India alone, 10-14 million metric tons of grains are lost yearly enough to feed one-third of its impoverished population (Anon., 2019). Insect pests, primarily from Coleoptera and Lepidoptera orders (Deshwal *et al.*, 2020), inflict both quantitative and qualitative losses. Primary pests like *Sitophilus oryzae* and *Callosobruchus maculatus* attack intact grains, while secondary pests such as *Tribolium castaneum* target damaged produce (Nayak *et al.*, 2020). Economically, these pests cause staggering losses ?1,300 crores annually in India (Anon., 2019) and 20-40% damage in sub-Saharan Africa (Affognon *et al.*, 2015).

Cereals (wheat, rice, maize) and pulses (chickpea, cowpea) are especially vulnerable, with bruchid beetles capable of destroying entire pulse stores within months (Mishra *et al.*, 2015). Dry fruits, a USD 2.5 billion industry, face threats from moths like *Plodia interpunctella* (Anon., 2022). Traditional storage (gunny bags, mud bins) fails to prevent infestations, prompting overuse of harmful fumigants (Upadhyay & Ahmad, 2023). Sustainable alternatives like hermetic bags (e.g., PICS) show promise, reducing losses by 90% (Baributsa *et al.*, 2017), but adoption remains limited among smallholders. Addressing these challenges requires integrated strategies: improved storage technologies, farmer education, and climate-resilient pest management (Aulakh *et al.*, 2013). Without intervention, storage pests will continue undermining food security and economic stability in vulnerable regions.

Material and Methods

The study focused on four cereals (rice, sorghum, maize, and wheat), four pulses (chickpea, cowpea, pigeon pea, and green gram), and two dry fruits (cashews and raisins) to assess insect pest damage. Insect pests were collected from infested grain lots and maintained in presanitized 2 kg plastic containers for culture development. Each container was covered with muslin cloth and secured tightly with rubber bands to prevent escape while allowing ventilation. Fresh seeds were provided regularly to sustain insect populations under room conditions. Continuous cultures were maintained through periodic sub-culturing using the same procedure to ensure a steady supply of insects for experimentation.

For the experimental setup, infestation-free seeds of all test crops were sun-dried and further sterilized in a hot air oven at 50°C for two hours to eliminate any pre-existing infestation. Clean plastic jars were filled with 500 g of sterilized grains, and ten pairs (20 adults) of newly emerged insects of each species were introduced into separate jars. Five replicates were maintained for each insect-crop combination. The type of grain provided (whole or split) was determined based on the feeding behavior of each insect pest. Observations were recorded at 15-day intervals over three months. Weight loss percentage was calculated using the formula:

$$\text{Per cent weight loss} = \frac{(\text{Initial weight} - \text{Final weight})}{\text{Initial weight}} \times 100$$

For insects that feed on whole seeds, percent seed damage was assessed by thoroughly mixing the seeds and randomly drawing five samples of 100 seeds each from every container. The number of damaged seeds in each sample was counted, and damage percentage was calculated as:

$$\text{Per cent damage} = \frac{\text{Number of damaged seeds}}{\text{Total number of seeds}} \times 100$$

Throughout the study, all containers and equipment were sterilized before use, and environmental conditions were monitored to maintain consistency. Control samples without insect infestation were maintained for comparison to account for any natural weight variations.

Results and discussion

Quantified progressive seed damage caused by storage insect pests across cereals and pulses over a 90-day period. Among cereals infested by *S. oryzae*, sorghum showed the highest susceptibility with damage escalating from 5.08% at 15 days to 80.42% at 90 days, followed by wheat (5.34% to 74.84%) and maize (4.92% to 70.94%). Pulse beetles (*Callosobruchus* spp.) demonstrated significantly greater destructive potential, with cowpea suffering catastrophic damage (97.1%) when infested by *C. maculatus* - the most severe pest-commodity combination observed. Other pulses followed similar vulnerability patterns: pigeon pea (94.14%), chickpea (89.37%), and green gram (89.40%). Notably, bruchid infestations progressed rapidly, exceeding 50% damage by 60 days in pulses, while cereals required the full 90 days to approach comparable loss levels. The results demonstrate clear interspecific variation in damage potential, with *Callosobruchus* species being particularly destructive to pulses compared to *Sitophilus* in cereals (Table 1 and Fig. 1).

Table 1: Per cent seed damage caused by different storage insect pests.

Treatment	*Seed damage during different intervals of storage					
	15 DAS	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**	**90 DAS**
Wheat+ *S. oryzae*	5.34 (13.36)[a]	14.31 (22.22)[d]	24.84 (29.89)[f]	31.56 (34.18)[f]	55.92 (48.40)[f]	74.84 (59.89)[e]
Maize+ *S. oryzae*	4.92 (12.82)[a]	12.62 (20.81)[e]	23.90 (29.27)[f]	33.48 (35.35)[e]	51.58 (45.91)[g]	70.94 (57.38)[f]
Sorghum+ *S. oryzae*	5.08 (13.03)[a]	15.26 (22.99)[c]	31.16 (33.93)[e]	44.54 (41.87)[d]	62.06 (51.98)[e]	80.42 (63.74)[d]
Chickpea+ *C. chinensis*	2.12 (8.37)[c]	9.78 (18.22)[f]	39.42 (38.89)[c]	53.69 (47.12)[c]	75.76 (60.51)[c]	89.37 (70.97)[c]
Pigeon pea+ *C. maculatus*	1.96 (8.05)[c]	15.86 (23.47)[b]	47.84 (43.76)[b]	63.01 (52.54)[b]	83.14 (65.76)[b]	94.14 (75.99)[b]
Cowpea+ *C. maculatus*	2.76 (9.56)[b]	16.84 (24.23)[a]	49.38 (44.64)[a]	65.36 (53.95)[a]	85.94 (67.98)[a]	97.10 (80.20)[a]
Green gram+ *Callosobruchus* sp.	1.82 (7.75)[c]	13.10 (21.22)[e]	38.22 (38.19)[d]	53.30 (46.89)[c]	74.88 (59.92)[d]	89.40 (71.00)[c]
S.Em±	0.11	0.18	0.42	0.34	0.27	0.26
CD @ 1%	0.45	0.69	1.63	1.33	1.05	1.03

20 Adults released, # - Figures in the parentheses are arcsine transformed values
*For whole grains (Seeds), DAS: days after storage

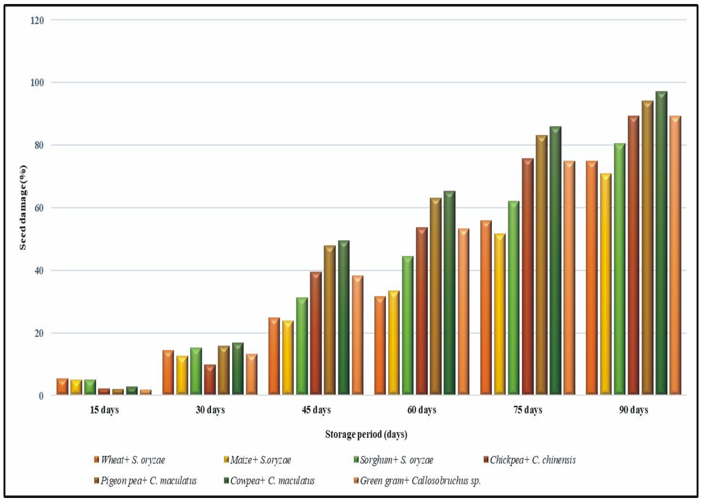

Fig. 1: Seed damage in different products during different intervals of storage

Increasing trend of weight loss caused by major stored grain insect pests over different storage intervals, from 15 to 90 days. Among cereals, *C. cephalonica* caused the highest weight loss on sorghum (9.23%) and rice (9.12%) after 90 days of storage. Similarly, in pulses, *C. maculatus* caused the maximum weight loss on cowpea (9.34%), while among dry fruits, *C. cephalonica* caused the highest weight loss on cashew (6.68%). Across all stored products, cowpea recorded the highest weight loss due to *C. maculatus* (9.34%). The weight loss percentages increased steadily over time for all pests and commodities. For cereals, *S. oryzae* caused significant losses, particularly on wheat (8.14%) after 90 days, followed by sorghum and rice. In pulses, *C. maculatus* caused substantial damage to cowpea and green gram, with losses up to 8.92%. For dry fruits, *O. surinamensis* caused notable losses on raisins and cashew, reaching 3.61% and 3.33%, respectively

Table 2: Weight loss (%) caused by different storage insect pests

Treatment	**Weight loss during different intervals of storage**					
	15 DAS	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**	**90 DAS**
Rice+ *C. cephalonica*	1.88 (7.88)[a]	2.54 (9.18)[b]	4.32 (12.00)[a]	6.33 (14.57)[ab]	7.90 (16.32)[ab]	9.12 (17.58)[a]
Sorghum+ *C. cephalonica*	1.74 (7.57)[ab]	2.54 (9.17)[b]	4.39 (12.09)[a]	6.46 (14.72)[a]	8.01 (16.44)[a]	9.23 (17.69)[a]
Raisins+ *C. cephalonica*	0.40 (3.64)[h]	1.35 (6.66)[f]	1.82 (7.76)[f]	3.26 (10.41)[i]	4.93 (12.83)[h]	5.91 (14.07)[f]
Cashew+ *C. cephalonica*	0.62 (4.51)[efg]	1.71 (7.51)[de]	2.70 (9.47)[e]	4.62 (12.41)[h]	5.61 (13.70)[g]	6.68 (14.98)[e]
Rice+ *S. oryzae*	1.55 (7.14)[c]	2.12 (8.37)[c]	3.35 (10.55)[c]	5.61 (13.70)[ef]	6.52 (14.79)[ef]	7.40 (15.79)[d]
Wheat+ *S. oryzae*	1.86 (7.83)[a]	2.57 (9.22)[b]	3.79 (11.22)[b]	5.92 (14.08)[cd]	6.83 (15.15)[de]	8.14 (16.58)[c]
Maize+ *S. oryzae*	1.31 (6.58)[d]	1.84 (7.79)[d]	3.42 (10.65)[c]	5.43 (13.48)[fg]	6.22 (14.44)[f]	7.33 (15.71)[d]
Sorghum+ *S. oryzae*	1.64 (7.36)[bc]	2.35 (8.82)[bc]	3.57 (10.89)[bc]	5.65 (13.75)[def]	6.62 (14.90)[ef]	7.57 (15.97)[d]
Chickpea+ *C. chinensis*	0.62 (4.50)[fg]	1.54 (7.12)[ef]	3.02 (10.00)[d]	5.85 (13.99)[cde]	7.43 (15.82)[bc]	8.62 (17.07)[b]
Pigeon pea + *C. maculatus*	0.44 (3.81)[fgh]	1.39 (6.78)[f]	2.94 (9.87)[de]	5.19 (13.16)[g]	7.23 (15.60)[cd]	8.49 (16.94)[bc]
Cowpea+ *C. maculatus*	0.73 (4.90)[e]	2.86 (9.74)[a]	3.59 (10.93)[cd]	6.09 (14.28)[bc]	8.11 (16.55)[a]	9.34 (17.80)[a]
Green gram+ *Callosobruchus* sp.	0.62 (4.52)[ef]	2.56 (9.21)[b]	3.33 (10.52)[c]	5.91 (14.07)[cd]	7.74 (16.16)[ab]	8.92 (17.38)[ab]
Raisins+ *O. surinamensis*	0.32 (3.22)[h]	0.98 (5.69)[g]	1.42 (6.83)[g]	1.82 (7.76)[j]	2.60 (9.28)[i]	3.61 (10.96)[g]
Cashew+ *O. surinamensis*	0.34 (3.35)[h]	0.91 (5.47)[g]	1.30 (6.55)[g]	1.73 (7.55)[j]	2.43 (8.96)[i]	3.33 (10.52)[g]
S.Em±	0.02	0.04	0.04	0.04	0.13	0.11
CD @ 1%	0.08	0.15	0.16	0.16	0.50	0.40

20 Adults released, # - Figures in the parentheses are arcsine transformed values, DAS: days after storage

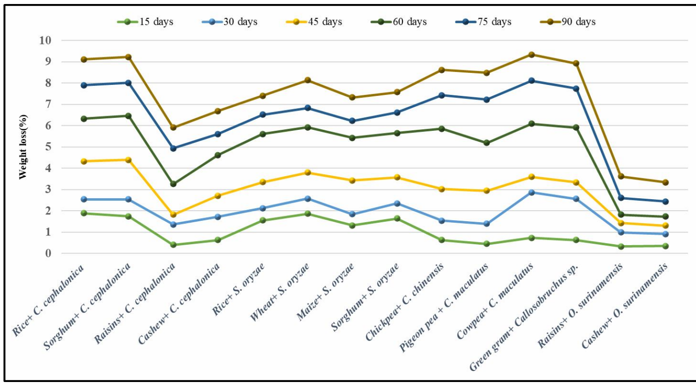

Fig. 2: Weight loss in different products during different intervals of storage

(Table 2 and Fig. 1).

This study provides comprehensive quantitative evidence of the severe impacts of storage insect pests on major agricultural commodities, with particularly alarming effects observed in pulse crops where *Callosobruchus maculatus* inflicted catastrophic damage to cowpea, reaching 97.10% seed damage and 9.34% weight loss after 90 days of storage, aligning with Deshpande *et al.*, (2011) who reported up to 97.29% infestation in susceptible cowpea genotypes but significantly exceeding the 39.3-58.5% damage range reported by Aly et al. (2005), demonstrating the extreme vulnerability of pulses to bruchid infestation that underscores their critical need for targeted protection measures as emphasized by recent studies (Babu *et al.*, 2020; Pradhan *et al.*, 2020), with the rapid damage progression in pulses exceeding 50% by 60 days suggesting conventional storage methods are inadequate for these high-protein crops and supporting calls for widespread adoption of hermetic technologies (Tefera *et al.*, 2016; Baributsa *et al.*, 2017), while cereal crops showed substantial but relatively lower impacts from *Sitophilus oryzae* with maximum damage observed in sorghum (80.42% seed damage, 7.57% weight loss) generally agreeing with Kumar et al. (2005) though significantly lower than field reports of 80% losses in traditional maize storage (Sori and Ayana, 2012; Nukenine *et al.*, 2002), a discrepancy likely reflecting the absence of compounding factors like microbial synergists and secondary infestations in controlled experiments as discussed by Jian et al. (2015), with the cereal susceptibility hierarchy (sorghum > wheat > maize) suggesting intrinsic factors like kernel hardness and nutritional composition influence pest preference and supporting Padmasri et al. (2017) hypotheses about physical and biochemical resistance mechanisms, while notably providing the first systematic documentation of *Corcyra cephalonica* impacts on dried fruits with measurable losses in raisins (5.91%) and cashew (6.68%) that establish critical baseline data for these high-value commodities despite being substantially lower than Lopez-Carvajal et al. (1996) field estimates of 25-100% damage in commercial storage, and confirming *Oryzaephilus surinamensis* as a significant secondary pest of processed products (3.33-3.61% damage) warranting inclusion in integrated pest management programs (Awadalla *et al.*, 2021), with the clear damage progression curves showing consistent acceleration of losses after 45-60 days across most commodities identifying a critical intervention window that supports Guenha et al. (2014) recommendations for timely monitoring and highlighting the need for commodity-specific solutions as emphasized by recent reviews (Upadhyay & Ahmad, 2023; Nayak *et al.*, 2020), where variations between our results and previous studies likely stem from genotypic differences in pest resistance (Pradhan *et al.*, 2020; Deshpande *et al.*, 2011), environmental conditions during storage (Jian *et al.*, 2015), pest population dynamics (Nayak *et al.*, 2020), and assessment methodologies (Kumar & Kalita, 2017), with findings having significant implications for food security and agricultural policy as the massive documented losses particularly in pulses represent both nutritional and economic crises for smallholder farmers that strongly support the need for accelerated development of hermetic storage technologies, breeding programs incorporating storage pest resistance traits, improved extension services focusing on post-harvest management, and policy interventions to make improved storage solutions accessible to smallholders, while future research should prioritize elucidation of biochemical resistance mechanisms (Mishra *et al.*, 2015), development of climate-resilient storage solutions (Aulakh *et al.*, 2013), economic analyses of post-harvest loss reduction interventions, and scaling pathways for smallholder adoption of improved technologies, with this study significantly advancing understanding of storage pest impacts while highlighting critical knowledge gaps particularly for understudied commodities like sorghum (Utono, 2013) and processed products through comprehensive quantitative data that serves as a valuable benchmark for future research and intervention development aimed at reducing post-harvest losses in diverse agricultural systems.

References:

Affognon, H., Mutungi, C., Sanginga, P. and Borgemeister, C. (2015). Unpacking postharvest losses in sub-Saharan Africa: A meta-analysis. *World Development*, **66**: 49-68.

Aly, M.A., El-Sayed, F.E.R.I.L. and El-Bishlawy, H.M. (2005). Damage and quantitative loss caused by Callosobruchus maculatus (*Coleoptera: Bruchidae*) to some cowpea and faba bean varieties. *Egyptian Journal of Agricultural Research*, **83(2):** 563-582.

Anonymous (2019). Indian Grain Storage Management and Research Institute (IGMRI), Hapur (U.P), Government of India. Available: www.igmri.dfpd.gov.in

Anonymous (2022). Food sector news-Dry Fruits and Nuts in India. Available: https://food.industry-report.net/dry-fruits-nuts-in-india/

Aulakh, J., Regmi, A., Fulton, J.R. and Alexander, C. (2013). Estimating post-harvest food losses: Developing a consistent global estimation framework. *Agricultural **Economics***, **44(S1):** 1-13.

Awadalla, H.S., Guedes, R.N.C. and Hashem, A.S. (2021). Feeding and egg-laying preferences of the sawtoothed grain beetle *Oryzaephilus* surinamensis: Beyond cereals and cereal products. *Journal of Stored Products Research*, **93:** 101841.

Babu, S.R., Raju, S.V.S., Dhanapal, R. and Sharma, K.R. (2020). Storage of chickpea grains (*Cicer arietinum* L.) in triple layer bags prevent losses caused by Callosobruchus maculatus (F.) (Coleoptera: Chrysomelidae) under laboratory conditions. *Journal of Stored Products Research*, **88:** 101685.

Baributsa, D., Lowenberg-DeBoer, J., Murdock, L.L. and Moussa, B. (2017). PICS bags for post-harvest storage. *Journal of Stored Products Research*, **72:** 1-8.

Deshpande, V.K., Makanur, B., Deshpande, S.K., Adiger, S. and Salimath, P.M. (2011). Quantitative and qualitative losses caused by Callosobruchus maculatus in cowpea during seed storage. *Plant Archives*, **11(2):** 723-731.

Deshwal, R., Vaibhav, V., Kumar, N., Kumar, A. and Singh, R. (2020). Stored grain insect pests and their management: An overview. *Journal of Entomology and Zoology Studies*, **8(5):** 969-974.

FAO (1997). Estimated postharvest losses in pulses in South east Asia. Food and Agriculture Organization of the United Nations, Rome, Italy.

Guenha, R., das Virtudes Salvador, B., Rickman, J., Goulao, L.F., Muocha, I.M. and Carvalho, M.O. (2014). Hermetic storage with plastic sealing to reduce insect infestation and secure paddy seed quality: A powerful strategy for rice farmers in Mozambique. *Journal of Stored Products Research*, **59:** 275-281.

Jian, F., Jayas, D.S. and White, N.D.G. (2015). Temperature fluctuations and moisture migration in wheat stored for 15 months in a metal silo in Canada. *Journal of Stored Products Research*, **64:** 1-9.

Kumar, S., Naganagoud, A. and Patil, B.V. (2005). Status on indigenous storage technologies for food grains followed in Northern Karnataka. *Karnataka Journal of Agricultural Sciences*, **18**(3).

Kumar, D. and Kalita, P. (2017). Reducing postharvest losses during storage of grain crops to strengthen food security in developing countries. *Foods*, **6(1):** 8.

Levinson, H.Z. and Levinson, A.R. (1985). Use of pheromone traps for the proper timing of fumigation in the storage environment. *EPPO Bulletin*, **15:** 43-50.

Lopez-Carvajal, A., Grijalva-Contreras, L., Valenzuela-Ruiz, J., Juarez-Gonsalez, R. and Robles-Contreras, F. (1996). Identification and Quantification of Damage to Raisins by Pest Insects in Northwestern Mexico. *Horticultural Science*, **31(4):** 678a-678.

Mishra, A.K., Karni, O. and Eisenstein, G. (2015). Coherent control in quantum dot gain media using shaped pulses: a numerical study. *Optics express*, **23(23):** 29940-29953.

Nayak, M.K., Daglish, G.J. and Phillips, T.W. (2020). Managing storage pests of grain: Challenges and opportunities. *Insects*, **11(12):** 846.

Nukenine, E.N., Monglo, B., Awasom, I., Tchuenguen, F.F.N. and Ngassoum, M.B. (2002). Farmers' Perception on some aspects of maize production and Infestation level of stored maize by S. zeamais in the Ngaoundere region of Cameroon. *Cameroon Journal of Biology and Biochemistry Science*, **12:** 18-30.

Padmasri, A., Srinivas, C., Vijaya Lakshmi, K., Pradeep, T., Rameash, K. and Anuradha, Ch.Anil B. (2017). Management of rice weevil (*Sitophilus oryzae* L.) in maize by botanical seed treatments. *International Journal of Current Microbiology and Applied Sciences*, **6(12):** 3543-3555.

Pradhan, L., Singh, P.S., Singh, S.K. and Saxena, R.P.N. (2020). Evaluation of certain chickpea genotypes against pulse beetle, *Callosobruchus chinensis* (L.) under laboratory conditions. *Journal of Entomological Research*, **44(4):** 535-539.

Sori, W. and Ayana, A. (2012). Storage pests of maize and their status in Jimma Zone, Ethiopia. *African Journal of Agricultural Research*, **7(28):** 4056-60.

Tefera, T., Mugo, S., Likhayo, P. and Beyene, Y. (2011). Resistance of three-way cross experimental maize hybrids to post-harvest insect pests, the larger grain borer (Prostephanus truncatus) and maize weevil (*Sitophilus zeamais*). *International Journal of Tropical Insect Science*, **31:** 3-12.

Upadhyay, R.K. and Ahmad, S. (2023). Management strategies for control of stored grain insect pests in farmer stores and public warehousing. *Journal of Stored Products Research*, **94:** 101876.

Utono, I.M. (2013). Assessment of grain loss due to insect pest during storage for small-scale farmers of Kebbi. *IOSR Journal of Agriculture and Veterinary Science*, **3(5):** 38-50.