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RESEARCH NOTE

Status of major storage pests and their natural enemies in stored maize of selected districts of Northern Karnataka

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Abstract: Maize is one of the major cereal crops grown for its food and feed values. It is one of the most important staple food and cash crops providing calories to the consumers and also income to the traders. Traditionally, maize grains are stored by the farmers both in and outdoors for consumption and they sell it in the later months of the year depending on the quantity produced per household. The stored maize is attacked and damaged by several storage pests that lead to quality deterioration forcing the farmers to sell their commodities at lower prices. The most important insect pests causing damage to stored grains belongs to the order Coleoptera and Lepidoptera. In order to know the major pests of stored maize with the per cent infestation they cause in selected districts of Northern Karnataka, a survey was carried out in different warehouses during 2020-21. Mean time, surveillance was made by procuring samples from Seed Unit, University of Agricultural Sciences, Dharwad. Results revealed that four coleopteran and one lepidopteran insects were found to be the common pests of stored maize in Dharwad, Davanagere and Haveri districts of Karnataka. However, *Sitophilous oryzae* (L.) being a key pest in all the warehouses of surveyed districts. Further, hymenopteran natural enemies belongs to four different families *viz*., Pteromalidae, Braconidae, Eupelmidae and Eulopidae were recorded during the surveillance.

Key words: Surveillance, Survey, Warehouse

Maize (*Zea mays* L.) is referred as queen of cereals since it has very high yielding potential and one of the largest cultivated cereal crops in tropical and subtropical climatic conditions worldwide. It is being used as food, feed, fodder and raw material in industries like beverage, confectionary, starch, ethanol, oil, cosmetic, pharmaceutical, food processing, textile, gum and paper industries. Apart from that, nutritionally it contains approximately 72, 10 and 4 per cent of starch, protein and fat, respectively and providing an energy density of 365 Kcal per 100 g. In addition, it has higher content of protein and fat as compared to other cereals (Hiruy and Emana, 2018). Though the production of maize has increased to meet the global demand, several biotic as well as abiotic factors are playing an important role in limiting the productivity. It is also overwhelmed with post production storage losses. After the harvest, farmers retain about 70 per cent of their agricultural produce for seed purpose, consumption and for sale. Most of our farmers are small and medium farmers who have no proper facilities for drying and storage. So, many times grains are subjected to attack by insects, rodents and mites resulting in both quantitative and qualitative loss. It has been reported that more than 37 species of arthropod insects are associated with stored maize (Abraham, 1997). Among the several insects attacking maize grains during storage, *Sitophilus oryzae* (*Linnaeus*), Lesser grain borer, *Rhyzopertha dominica* (*Fabricius*), Red flour beetle, *Tribolium castaneum* (Herbest), Rice moth, *Corcyra cephalonica* (Stainton) and Angumois grain moth, *Sitotroga cerealella* (Olivier) are of economic importance.

In order to establish efficient storage pest management measures, it is crucial to first understand how an infestation occurs by insect pests. Conducting survey is the best way to know the range of distribution of pest population, intensity of infestation and reasons for the infestation. A survey conducted by Tadesse *et al*. (2020) revealed that the annual loss of grains due to insect infestation was accounted to 5.90 million tonnes. Similarly, Government of India expert committee on food losses estimated 9.30 per cent grain losses, of which 3.50 per cent loss was due to insects alone (Swamy *et al*., 2014) which represents the role of stored grain pests in food losses. Hence, survey is the primary tool to estimate the extent of relative damage caused by major pests of stored maize to be ascertained in major maize growing districts of North Karnataka which would provide a base for developing a new approach to manage storage pests to cater needs of the farmers.

Survey was carried out for six times at one month interval from December 2020 to May 2021 in major maize growing districts of Karnataka where maize was stored (Table 1). In each locality, 250g of infested seed samples were collected from seed lots and brought to the laboratory (Department of Agricultural Entomology, College of Agriculture, Dharwad) for further assessing the intensity of damage made by the pests of stored maize. Mean time, surveillance was carried for six times at fortnight interval from December 2020 to February 2021 and the samples of 250 g of seeds were procured from Seed Unit, University of Agricultural sciences, Dharwad for further studies to laboratory.

The samples were observed for emergence of pests, parasitoids and predators, which were preserved and identified

Table 1. List of locations for procurement of seeds during survey

Name of warehouse	Location
Central Warehousing Corporation (CWC)	Haveri
Central Warehousing Corporation (CWC)	Hubballi
Karnataka State Seed Corporation Agency (KSSCA)	Dharwad
Central Warehousing Corporation (CWC)	Dharwad
Agriculture Produce Market Committee (APMC)	Dharwad
State Warehousing Corporation (SWC)	Davanagere

with help of morphological characters using the keys. However, those which are difficult to identify, were sent to the ICAR-National Bureau of Agricultural Insect Resources (NBAIR) Bengaluru and GKVK, UAS, Bengaluru for identification. Observations were also made on commodities stored, per cent of infestation using below mentioned formula for pest damage and parasitoids or predators found in storage units.

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

Based on the results of the survey conducted during December 2020, the per cent infestation was more in the sample collected from SWC, Davanagere (6%) which was infested by *T. castaneum* pest. However, samples collected from CWC, Dharwad and CWC, Hubballi had noticed with least infestation percentage of 2.00 per cent. The samples procured from CWC, Haveri and APMC, Dharwad were both being recorded 3.00 per cent whereas KSSCA Dharwad registered 5.00 per cent infestation (Table 2). However, infestation level during January 2021 indicated that, the maximum infestation of 7.00 per cent was manifested in a sample procured from SWC, Davanagere with an infestation of *S. oryzae*. However, least infestation of 3.00 per cent was witnessed with sample of CWC, Haveri, Dharwad, Hubballi and APMC Dharwad with an infestation of *S. oryzae* only. Meantime, samples procured from KSSCA Dharwad registered with 4.00 per cent of infestation caused by *T. castaneum.* Similar trend of observation was noticed during February 2021 where SWC, Davanagere with an infestation of *T. cataneum* registered highest damage of 8.00 per cent, whereas, same pest species had a 5.00 per cent infestation in the commodity procured from KSSCA, Dharwad. Samples procured from CWC, Haveri and APMC, Dharwad were both being registered with 4.00 per cent infestation caused by *S. oryzae*. However, lowest per cent of infestation of 3.00 per cent was noticed in the samples procured from CWC, Hubballi and CWC Dharwad with *S. oryzae*.

Mean while, highest infestation of 13.00 per cent damage was caused by two coleopteran pests namely *T. castaneum* and *S. oryzae* in a commodity procured from KSSCA, Dharwad and was followed by 11.00 per cent infestation in a sample collected from SWC, Davanagere which was infested by *T. castaneum* during March 2021. However, lowest infestation per cent of 3.00 per cent was noticed in a commodity procured from CWC, Hubballi. Conversely, highest infestation of 23.00 per cent was manifested in SWC, Davanagere during April month due infestation of two pest species *viz*, *S. oryzae* and *C. cephalonica* and was followed by 12.00 per cent of infestation in a sample collected from KSSCA, Dharwad, due to infestation of *S. oryzae*. However, moderate infestation of 7.00 per cent was noticed in a sample collected from APMC, Dharwad whereas, CWC, Haveri and Dharwad both registered 6.00 per cent infestation with *S. oryzae*. However, lowest infestation of 5.00 per cent was observed at CWC, Hubballi. (Table 2).

Adverting maximum infestation of 39.00 was manifested in commodities procured from SWC, Davanagere due to the infestation by the pest complex *viz*, *T. castaneum*, *R. domonica* and *C. ferrugineus* during May month. Correspondingly 11.00 per cent in KSSCA, Dharwad, due to infestation of *S. oryzae* only, which indicating its dominance. Locations where infestation is moderate were APMC Dharwad (9.00%),

Table 2: Survey for storage pests of maize during from December 2020 to May 2021

Location	Months											
	December 2020		January 2021		February 2021		March 2021		April 2021		May 2021	
	Pests observed	Per cent infestation	Pests observed	Per cent infestation	Pests observed	Per cent infestation	Pests observed	Per cent infestation	Pests observed	Per cent infestation	Pests observed	Per cent infestation
CWC, Haveri	*S. oryzae*	3	*S. oryzae*	3	*S. oryzae*	4	*S. oryzae*	6	*S. oryzae*	6	*S. oryzae*	6
CWC, Dharwad	*S. oryzae*	2	*S. oryzae*	3	*S. oryzae*	3	*S. oryzae*	5	*S. oryzae*	6	*S. oryzae*	5
KSSCA, Dharwad	*S. oryzae*	5	*T. castaneum*	4	*T. castaneum*	5	*T. castaneum* *S. oryzae*	13	*S. oryzae*	12	*S. oryzae*	11
CWC, Hubballi	*S. oryzae*	2	*S. oryzae*	3	*S. oryzae*	3	*S. oryzae*	3	*S. oryzae*	5	*S. oryzae*	6
APMC, Dharwad	*S. oryzae*	3	*S. oryzae*	3	*S. oryzae*	4	*S. oryzae*	4	*S. oryzae*	7	*S. oryzae*	9
SWC, Davanagere	*T. castaneum*	6	*S. oryzae*	7	*T. castaneum*	8	*T. castaneum*	11	*T.castaneum* *C. cephalonica*	23	*T. castaneum* *R. dominica* *C. ferrigineus*	39

CWC: Central Warehousing Corporation
APMC: Agriculture Produce Marketing Committee
SWC: State Warehousing Corporation,
KSSCA: Karnataka State Seed Corporation Agency

Table 3. Surveillance for storage pests of maize during December 2021 to February 2021

Location	Months	Duration of grains stored (months)	Pest observed	Per cent infestation	No of pests/250g sample		Natural enemies observed
					Live	Dead	
Seed unit, University of Agricultural Sciences, Dharwad.	I FN of December	3.5	*S. oryzae*	9	39	9	-
	II FN of December	4.0	*S. oryzae*	13	47	11	-
	I FN of January	4.5	*S. oryzae*	28	38	13	Pteromalidae*
	II FN of January	5.0	*S. oryzae* *T. castaneum*	31	4347	1715	Eupelmidae*
	I FN of February	5.5	*S. oryzae*	36	3443	1316	Pteromalidae*
			T. castaneum		41	17	Braconidae*
			C. cephalonica				
	II FN of February	6.0	*S. oryzae*	41	4751	1317	Eulophidae*
			T. castaneum		49	19	Braconidae*
			C. cephalonica				Eupelmidae*

*Specimens identified up to family level; FN- Fortnight

CWC, Hubballi (6.00%) and CWC, Haveri (6.00%) with *S. oryzae* infestation only. However, lowest infestation was noticed in CWC, Dharwad with 5.00 per cent damage. It was evidently witnessed from the current study that a totally four coleopteran pests *viz*., *S. oryzae*, *T. castaneum*, *C. ferrugineus*, *R. dominica* and one lepidopteran pest like *C. cephalonica* were documented during the survey with *S. oryzae* being a predominant pest across the locations.

The above findings were supported by the results of Awaknavar (1991) who recorded 28 storage beetle pests belonging to 21 genera and 11 families in different warehouses of Dharwad district of Karnataka. Mahanti (2002) also stated that most predominant pest on stored maize was *S. oryzae*. Increased infestation in certain localities may be attributed to the level of infestation accomplished with complexity of pest, source of infestation, duration of storage and hygienic condition of the location.

Results of surveillance conducted from December 2020 to February 2021, revealed gradually inclined trend of population over the period of time. Wherein lowest incidence of 9.00 per cent was noticed during I FN of December due to infestation of *S. oryzae* from 3.5 months old grains where as it was 28 per cent of infestation in a 4.5 months old sample collected during I FN of January with 38 live and 13 dead adults of *S. oryzae* infestation. However, infestation enhanced to 31 per cent in II FN of January. Furthur, infestation had raised to 36 per cent in I FN of February with pest complex of *S. oryzae*, *T. castanaeum* and *C. cephalonica* with 34, 43, 41 live and 13, 16, 17 dead insects, respectively. The maximum infestation percentage of 41.00 was noticed during II FN of February in a 6.0 months old sample with the pest complex of *S. oryzae*, *T. castanaeum* and *C. cephalonica* (Table 3).

Findings of current study witnessed per cent infestation were directly proportional to the duration of storage of commodities with pest complex. The higher level of infestation might be due to the enhancement of pest complexity which includes primary and secondary pests *viz*., *S. oryzae*, *T. castaneum* and *C. cephalonica* with the prolonged duration of storage. It may also attributed by abiotic factors like temperature and relative humidity which had positive correlation with the level of infestation as reported by the earlier workers (Meena *et al.,* 2017) and was ascertained in present study. The present findings are also in accordance with Sori and Ayana (2012) who stated that per cent infestation enhanced progressively with increase in storability of the commodity.

During the surveillance, parasitoids belongs to four different families of order hymenoptera were observed on stored maize namely, Braconidae, Eulophidae, Eupelmidae and Pteromalidae. Among these, members of family Pteromalidae and Eupelmidae were noticed during I FN and II FN of January, respectively. Whereas, Braconid sp along with Pteromalid sp were recorded in I FN of February and complex of three species *viz*, Eulopid, Braconid and Eupelmid were evidented in II FN of February (Table 3). Species level identification is yet to be ascertained. These results are supported by the findings of Abraham (1997) who recorded hymenopteran natural enemies belongs to the family Pteromalidae and Eupelmidae in stored maize.

Insect pests detected in stored maize during the survey were Rice weevil, *Sitophilus. oryzae* (Linnaeus); Lesser grain borer, *Rhyzopertha dominica* (Fabricius); Rust red flour beetle, *Tibolium castaneum* (Herbest); Flat grain beetle, *Cryptolestes ferrugineus* (Stephens); Rice moth, *Corcyra cephalonica* (Stainton). Similar insect pests were documented during surveillance except lesser grain borer and flat grain beetle. However, *S. oryzae* found to be most abundant pest in all the surveyed warehouses. Infestation was more in the localities where commodities were stored for longer period with increasing pest complexity which includes primary and secondary pests. Four natural enemies belong to four different families of order Hymenoptera were recorded during surveillance.

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