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Effect of Biotic and abiotic factors on mites infestation under grain storage- A review

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ABSTRACT

Mites are common pests of stored grain containing high fat and protein content. They are considered secondary invaders among the diverse range of storage pests because they are unable to infest sound grain and instead feed on fractured kernels, debris, and high moisture grain that has been already damaged by some insect pests. The high humidity and optimum temperature are determining factors for the sensitivity of the food grains for mites attack. Mites directly risk human health by contaminating food and indirectly by mycotoxin released under storage conditions. They also result in a considerable loss in grain weight and a reduction in germination ability. The losses become more severe as the mite population grows. Chemical agents have traditionally been used to prevent or manage mite infestations, as it is the simplest and most cost-effective approach to dealing with stored grain mites. This review paper discusses Distribution, pest status, host range, food grain choice, abiotic factor influence, quantitative damage, change in biochemical composition, and botanicals for mite management.

Figure : 00 References : 29 Table : 00

KEY WORDS : *Acarus spp.,* Mites, Stored grain pests, *Tyrophagus spp.,* Zero tolerance policy

Introduction

Mites under storage conditions are among the most troublesome pests. They possess high multiplication rates, short life span, and overlapping generations. Mites interact with insects and fungi and cause quantitative and qualitative deterioration of stored grains [6]. Grain is a rich source of nutrients for a wide range of species. The interactions between grain and mites are mostly determined by the micro-environment in which the grains are stored, which results in grain bio-deterioration. Mites cause approximately 20-30% damage to stored grains and grain products in the tropical zone, which is extremely high when compared to the temperate zone at approximately 5-10% percent [7]. In Traditional storage systems damage may reach up to 40%, especially in emerging and underdeveloped countries [10]. After establishment, they contribute directly to grain spoiling with pathogenic interaction. They show high interaction with fungi and insects, the harm caused by stored-grain mites is usually undetectable until the grain is minutely observed and taken out from the storage facility. When the storage environment is hot and humid, mites compensate for their tiny size by causing more severe damage to stored commodities by exploding their population. Mites will multiply 500 times every month under ideal conditions of 30 degrees Celsius and 75% relative humidity [15]. These mites can grow on seeds with a moisture level of more than 8%. They eat fungus that grows on seeds and broken seeds. Seeds with less than 8% moisture content have little influence from the mites[19]. Grain purchasers all around the world are adopting a zero-tolerance policy against storage pests. Until recently, storage authorities regarded mites as nuisance pests or contaminants of minimal economic relevance, and some nations have a legally defined zero-tolerance policy for stored-grain insects only. For two key reasons, mites are adopting significant pest status. Firstly markets are becoming more aware of mite pests' potential and their contaminants. Secondly, management techniques developed for insect pests do not work on these pests[12].

Worldwide Distribution of Mites

Mites are small that are very difficult to spot and go undetected for long periods. Mites infesting stored grain have been studied in a variety of locations across the world. So far, seventy different species of stored grain mites have been identified. *Acarus sp., Tyrophogus sp., Suidasia sp., Glycyphagus sp., Lardoglyphus sp.,* and *Lepidoglyphus sp.* are the most common acarid mite pest species [22]. *Acarus siro*, also known as the grain or flour mite, is a major and ubiquitous pest of stored grain and grain products. *A. siro*, which is major species found in stored-product environments while *A. farris*, and *A. immobilis* species occur under field conditions and are occasionally transferred to storage establishments. Most recently a complex of all three species was discovered under stored grain also. There are no well-defined physical boundaries for this species' life and development [23]. Acaridae mites are more important as storage pests, causing rapid qualitative and quantitative deterioration of grains. Acarid mites-infested storage grains had been studied by several researchers throughout the world. *Tyrophagus putrescentiae* is a common, agriculturally significant mite that is a serious pest of a variety of stored grains with high fat and protein content all over the world. They are very important pests in the tropical region. *T. americanus, T. breviceps, T. cocciphilus, T. castellanii, T. australasiae, T. neotropicus Oudemans, T. amboinensis Oudemans, T. communis, and T. nadinus* are all species of *Tyrophagus*[13]. *Tyrophagus spp.* possess ability to survive under low humidity and a wide range of temperatures. It also infests cultivated mushrooms, dirt, mosses, trash, storehouses, barns, and storage buildings. Pollen has also been found infested with this species. This mite causes weight loss and food deterioration through the buildup of fungi. Grain impurity due to dead mites, feces, eggs, and food fragments results from a high level of grain contamination[14].

Pest status and host range of stored mites

Grain, flour, cereals, pet meals, mould, dry pet food, baking mixes, grain goods, dried vegetable materials, cheese, corn, and dried fruits have all been found to be infested by stored mites. Mites are a major pest of many stored grain, as well as rotting plant and animal materials. Mold mite is a frequent pest of wheat, pulses, millet, peanuts, cheese, mushrooms, and other preserved items with a high fat or protein content. Mixed feeds, brewer's yeast, whole-wheat flour; soy flour; wheat germ, cheese, rye bread, white bread, and oat-barley combinations have all been found to contain it [4]. Cultivated mushrooms, various seeds, fruits, grain, and straw stacks in the field, decomposing animal and vegetable debris, onion, rapeseed, bacon, figs, dried milk, cheese, ham, dried bananas, Chinese herbal medicine, edible mushrooms, and copra are among the other delicacies known that are infested by mites. In Queensland, Australia, *T. putrescentiae* is the most common mite found in livestock feed [3].

Susceptibility/preference of food grain/ products

Mite activities cause the breakdown of stored goods by accumulating hazardous residues (fungi, dead mites, faeces, eggs, and food parts). Mites cannot penetrate grains if the grain coat is intact, but scarification occurs during storage, which allows mites to penetrate. This indicates that mites prefer the germinal portion of the grain. Earlier researchers[29] recorded the relationship that on a limited amount of substrate, the mean consumption of one individual was indirectly proportional to the population size [20]. It has also been discovered that mites are generally more abundant in the flour form of stored grains than whole and broken grains. However, once the population has established itself on the whole grains, it contaminates them with its excreta, emits a pungent odor, and turns them into a powdery mass [21]. The amount of damage caused by storage mites is determined by how quickly the population can grow and how long it has been since the stored grain was originally infested. Mites can live in stored products for a short life cycle and reproduce quickly, which varies based on the availability of food, humidity, and temperature. Mites take 9.4, 7.2, and 8.5 days to develop from egg to adult in ideal conditions at 25, 30, and 32.5 degrees Celsius, respectively [24].

Mite's population growth was influenced by the availability of extra protein or saccharide sources in the diet. When yeast powder, glucose, or sugar were added to the basic wheat bran diet, the population of *T. putrescentiae* arose by 319, 317, and 180 times after six weeks, respectively, compared to the basic diet, where it multiplied by just 70 times [25]. When grains are infested with mites, they undergo a sequence of chemical changes, which results in nutritional losses. Changes in the chemical content of preserved foods, human allergy reactions, and the spread of toxigenic fungi like *Aspergillus spp.* and *Penicillium spp*. [28]. *T. putrescentae* emits a cause's pungent odor when infested, also called a "lemon-scented mite". Secretions of lipids by mites, the stored product may develop a minty odor. The farmers and workers who handle heavily infested stored products may cause some type of allergic disease. Acute enteritis, diarrhea, dermatitis, asthma, pulmonary acariasis, and urinary acariasis can all be caused by them. Mite outbreaks, in addition to causing significant damage to stored commodities, appear as moving carpets of brown dust on the commodities, silos, and sheds, causing discomfort to workers [27].

Influence of abiotic factors on mite behaviour

Temperature and moisture influence the feeding and reproductive behavior of mites. According to a study, mites mating and oviposition occurred shortly after emergence in *T. putrescentiae* and *A. siro* at 20°C and 80% relative humidity, but egg laying was delayed at low temperatures. *T. putrescentiae*, a photonegative mite, when light exposure increased, fecundity, egg viability, and hatching period was significantly reduced, and the life cycle was significantly prolonged[5]. Habitat, food source, humidity levels, light levels, wind, temperature, prey availability (predator-to-prey ratio), and foliage condition (turgid versus withered) [11]. Dispersal was decreased at low temperatures (15°C) and increased at medium and high temperatures (25-35 °C). As prey density decreased, mites dispersed in search of new food sources or risked starvation[16]. Several researchers have researched the effects of temperature on the growth of acaroid mites, yielding a wealth of information, particularly on the optimum temperature ranges for their development and rapid reproduction [20]. The study established that the temperature and humidity thresholds beyond which the grain mite, *Acarus siro*, is unable to complete its life cycle. Various stages of mites were moved from laboratory cultures to micro-cells when they were exposed to temperatures ranging from 0 to 35°Celsius and a graded sequence of relative humidity levels ranging from 60 to 100%. Adult survival, oviposition, and egg hatching were all tracked. Although a few animals were successfully reared at around 100% R.H. and 15 °C, there was a substantial rate of failure [8].

Temperature influences the lowest humidity limit. At 10-20 °C, only a tiny percentage of individuals finished the embryonic cycle at 62.5 percent R.H., while at 60 percent R.H., adults survived for only a short time, and few eggs were deposited [25]. The low humidity limit increases as the temperature rises at 25°C, it was between 65 and 67.50 percent, and at 30°C, it was between 70 and 72.50 percent. The upper-temperature limit was between 31 °C, where a few individuals completed their growth at 90% R.H. or higher and 32°C, where none did the lower temperature limit was below 5 degrees Celsius but above 0 degrees Celsius, below which no eggs hatched and above which no eggs hatched[1].

Effect of mite infestation on germination of grains

The mites feed on the embryo, causing germination loss in the grains as well as deterioration in the quality of seed and flour prepared from infested grains, making it unsuitable for milling and unpalatable to livestock. Because of their small size, many commercial farmers are unaware of the damage and losses caused by stored grain mites [9]. Mites cause direct damage to stored grains by contaminating and penetrating the seeds/embryo, consuming the grain germ and endosperm, which reduces the vitality and germination capability of the seeds. The grain is rendered unfit for seed or brewing and is unacceptable to the miller. Furthermore, mites can feed on the germ of kernels, reducing the iron and vitamin B complex as well as germination ability. Several reports indicate that weight loss and seed germination are reduced as a result of mite infestation. A worker[26] observed 68.5 percent germination in pearl millet seeds after 24 weeks versus 92.85 percent at 0 weeks due to mite infestation [26]. It was also suggested that the additional loss in percentage germination could have been caused by heating. If there are enough insects, mites, and fungi actively growing in a consignment of stored produce to generate heat faster than it can escape the temperature of the product rises and may reach 42 to 46^{0}C. This high temperature hastens the physiological decline, resulting in a loss. The mite population in maize increased from 3.3 to 6.6 mites over three months, germination decreased from 86-91 to 74.67-81 percent [17]. The following are the ways required for mite contamination detection:-

1) Identification of actual medical risk densities when density is greater than mites per g
2) Identification of risk-potential densities when density is between 5 and 1 mite per g.
3) Identification of grain that was or still is contaminated by mites but is below the detection limits of conventional methods [2].

From this perspective, all detection methods, including traditional sieving, are ineffective. The materials were extracted in Berlese Tullgren funnels, sieved, and processed by floatation utilizing an enzyme-linked immunosorbent test (ELISA) using anti-*A. siro* polyclonal antibody (immunochemical technique) (conventional methods). All three traditional methods used to detect *A. siro* adults or juveniles were successful [3].

Potential of botanicals for mite management

Plant-derived extracts, powders, and essential oils may be effective mite management tools. Plant-derived alkaloids, alcohols, aldehydes, terpenoids, and some monoterpenoids act as a fumigant. Several studies have shown that plant essential oils are effective at controlling pests in stored products. Among botanicals, *Allium sativum, Curcuma longa, Azadirachta indica, Glycyrrhiza glabra,* and *Ocimum sp.* have been reported to have toxic and repellent effects on storage mites and insects. Other botanicals that demonstrated acaricidal activity against the phytophagous mite, *Tetranychus urticae,* include *Withania somnifera* and *Pongamia pinnata* [18].

Conclusion

Mites are common pests of stored grain that prefer a damp and moist type of broken grain. Due to their small size, most of them go unnoticed. Mites cause great loss to grain by demolishing its nutritional composition which includes protein, total soluble sugar, non-reducing sugar, starch, *etc.* and also the germination ability of grains. Botanicals are effective ways for mite management since they act in diverse ways like antifeedants, attractants, repellents, growth retardants, and toxicants. Compared to synthetic insecticides, botanical insecticides need more promotion. It is also important to raise awareness among farmers to use botanicals for stored pest management. In international markets due to zero pest policies, it becomes more important to focus on unnoticed storage mite infestation. Good management practices need to be adopted based on the understanding of several biotic and abiotic factors influencing the storage mites population.

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