Study On Effect Of Feeding Fusarium Contaminated Grain To Livestock And Management Strategies

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ABSTRACT
Different grasses and crops are susceptible to the parasite infection known as fusarium head blight. It is found most frequently in wheat, but can be in grain, oats, rye and a few forage. Beneath certain natural conditions the fusarium shape may deliver a mycotoxin. Fusarium infected grains produces a mycotoxin is called deoxynivalenol (DON), and it is considered a mild poison of animals, compared to other poisons that can frame in grains and forages. Fusarium Head Blight is favored by warm, muggy conditions amid blooming and early stages of part advancement. Livestock may experience diminished nourish intake, diminish in execution and diminished resistant work as it were indications of DON toxicity. DON has been shown to be poorly absorbed, extensively metabolized and rapidly cleared from tissues and fluids in ruminant animals and poultry. In spite of the fact that distinctive animals species respond in an unexpected way to this mycotoxin, creatures expending high levels of DON may involvement decreased feed intake, decreased resistant reaction and reproductive brokenness. It is basic to utilize a combination of agronomic procedures to restrain the introduction, development and spread of Fusarium Head Blight. The current study addresses the effect of feeding Fusarium contaminated grain to livestock and management strategies.

Keywords: Fusarium, livestock, mycotoxin, FHB, contaminated feedstuff, deoxynivalenol (DON)

Introduction

The dangerous parasite disease fusarium head blight (FHB), often known as scab or headstone, affects maize, wheat, barley, oats, and other small cereal grains (Parry et al 1995, McMullen et al 2012). It can too influence wild and tame grass species. In any case, the crops most influenced are wheat, grain and corn. FHB-infected grain may contain fungus-produced harmful substances called mycotoxins. The foremost common mycotoxin associated with Fusarium-infected grain within the northern incredible fields is deoxynivalenol or Don (vomitoxin) (Nganje et al 2004).Fusarium graminearum produces mycotoxins in contaminated commodities is Deoxynivalenol (Don). They apply their impacts through four essential mechanisms viz; i) lessening in nourishment intake or expanded feed refusal, ii) change in supplement substance of feed, and supplement assimilation and digestion system; iii) changes within the endocrine and exocrine frameworks; and iv) cover-up of the immune system

Fusarium Head Blight (FHB)

Fusarium head blight is the most hazardous infection, which is also accompanied by grain that is tainted with mycotoxin (DON). Fusarium spp. poison grain heads at various times, but the cereals most susceptible to contamination are those that are in the flowering stage and immediately following blooming, thrive in hot, humid areas with plentiful dew and prolonged precipitation during this period (Osborne et al 2007, Hjelkrem et al 2017)

While the grain is in the milk formation stage, infection symptoms on the contaminated head are obvious. Fusarium spp.-contaminated spikes eventually turned completely white or formed separate fleurs. After a few days of illness, spikes of pink or salmon-colored sporodochia that are covered in mycelium layer and contain conidial spores appear on contaminated chaff. The growth of kernels is suppressed by the death of contaminated spikelets, which lowers the number of grains in the spike. In contaminated heads, the remaining parts are frequently smaller, greyish, shrunken, open, and generally linked with sporodochia and Fusarium spp. mycelium (Parry et al 1995, Goliński et al 2010). Damage to starch granules and changes in capacity protein composition were noted in sections contaminated by Fusarium spp. (Packa et al 2012). Fusarium spp. damage severity and grain quality may be significantly influenced by these parasites' capacity to transmit mycotoxin (Desjardins 2006).

Life Cycle Fusarium graminearum

The life cycle of Fusarium graminearum, responsible for Fusarium head blight (FHB) in wheat, unfolds as a multifaceted and dynamic process intricately woven into the fabric of various environmental factors. A comprehensive comprehension of this life cycle is imperative for the formulation of impactful management strategies against this formidable fungal pathogen. Commencing with the genesis of airborne spores, or conidia, the life cycle finds its origins in infected crop residues or the enigmatic perithecia, sexual structures emerging from diseased plant remnants. Disseminated by the whims of wind and the whimsy of rain, these conidia embark on a journey, landing on susceptible wheat heads during the delicate flowering stage. Here, they delicately adhere to the flowering spikelets, germinating under optimal environmental conditions. The germinated conidia give rise to specialized infection structures called appressoria, facilitating penetration of plant tissues, ultimately leading to F. graminearum invading the wheat spikelet, inducing characteristic symptoms of bleaching and necrosis. Beyond this, the fungus showcases its capacity for sexual reproduction through perithecia, producing ascospores explosively ejected into the air, serving as additional inoculum for future infections. The dance of environmental conditions, swaying between warmth and humidity during flowering and dryness at harvest, orchestrates the progress of F. graminearum life cycle. To effectively combat Fusarium head blight, a holistic strategy is indispensable—planting resistant wheat varieties, embracing cultural practices like crop rotation and residue management, and timely fungicide applications during critical growth stages. Augmenting this approach, forecasting models based on weather conditions offer a prophetic lens, empowering farmers to implement timely control measures and fortify their defenses against the insidious spread of this fungal pathogen.

Deoxynivalenol (DON) Production

Vomitoxin/DON (Deoxynivalenol) is a member of the trichothecenes family of mycotoxins. Trichothecenes are structurally related compounds synthesized by Fusarium species of fungi, and they include T-2 toxin, nivalenol, DON, and satratoxins (Pitt 2000). F. graminearum and F. culmorusis, which contaminate wheat, barley, oats, rye, and corn, are the main sources of deoxynivalenol. These two Fusarium species are plant pathogens that cause illnesses in plants like wheat head blight and maize ear blight (Kim et al 2016).

Fusarium produces the mycotoxin deoxynivalenol, which is frequently recognized in cereals like corn, wheat, barley, and oats. Because it was first connected to vomiting in pigs, it is occasionally referred to as vomitoxin. Although the effects of DON on dairy cattle are unknown, clinical studies indicate a link between diets contaminated with DON and subpar dairy herd performance (Whitlow et al 1994). For instance, mid-lactation milk production was reduced by 13% (P=0.16) in a Canadian study utilising 18 first-lactation cows fed a diet polluted with DON (4 to 5 ppm) compared to cows on clean feed (Charmley et al 1993). Up to 21 ppm of DON has been tolerated by sheep and cattle without causing any noticeable effects. DON has an impact on the liver's capacity to detoxify. It also produces a significant drop of milk production, fat in the milk and increased somatic cell count.

Toxicity of DON:

The harmful impacts of Don are due to the free OH groups and the epoxide ring (Marin et al 2013, Sobrova et al 2010). Potential impacts on human and animal wellbeing happen after ingestion of contaminated material. Swine are the foremost sensitive species(Cheat et al 2015). The most harmful impact of Don is the restraint of protein blend and mitochondrial function. Since these influences quick developing cells in specific, Don leads to impacts such as immunosuppression and immunomodulation (increased vulnerability to opportunistic and common pathogens) and cytotoxic effects (Cheat et al 2015, Sobrova et al 2010).

Impacts on the gastrointestinal tract incorporate gastroenteritis (swelling of stomach and digestive system); disability of intestine integrity and affect on intestinal microflora; loose bowels; intestinal dying; anorexia; diminished dietary proficiency; expanded liver measure; extreme immunosuppression; diminish in nourish intake and diminished weight gain (Grenier et al 2013, Maresca 2013). Other impacts that are common among this course of trichothecenes are common weakness; devastation of bone marrow; decay in serum proteins and egg whites levels; diminish in hematocrit (ruddy blood cell concentration in blood); diminishment of serum calcium and phosphorus; neurotoxic effects(Cheat et al 2015, Pinton et al 2014, Sobrova et al 2010).

Effect on livestock feed

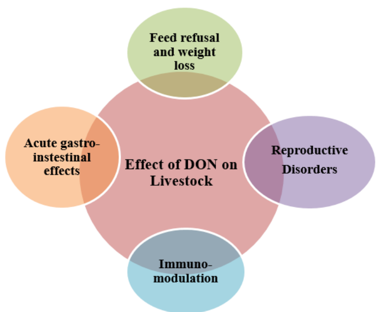

Figure 1: Effects of DON on Livestock

On Cattles

The affect of Don on dairy cattle isn't established, but clinical information show a link between Don and poor performance in dairy cattles (Whitlow et al 1994). Dairy cattle devouring diets contaminated essentially with Don (2.5ppm) have reacted favorably (1.5kg drain, P<.05) to the dietary consideration of a mycotoxin binder, giving circumstantial prove that Don may diminish milk production (Diaz et al 2001).

Mid-lactation field results from a Canadian study utilising six first-lactation dairy animals (normal 19.5 kg drain) appeared that dairy animals expending DON-contaminated diets (2.6 to 6.5ppm) tended (P<0.16) to create less drain (13% or 1.4kg) than did cows devouring clean feed (Charmley et al 1993). Don had no impact on milk production in eight cows encouraged over a 21-day period. Don has been related with changed rumen fermentation (Seeling et al 2006) and decreased stream of utilizable protein to the duodenum (Danicke et al 2005). Don has been consumed by sheep and calves in amounts up to 21 ppm without producing any noticeable effects (DiCostanzo et al 1995).

Swine

Pigs show a high sensitivity to DON or vomitoxin. Vomitoxin once in a while induces vomiting in swine. Intense poisonous quality is exceptional, but in that case vomit, loose bowels, serious stomach related injuries, and sudden death happen (Young et al 1983). Persistent vomitoxin toxicity is more common and of viable significance. In most cases, a sharp decrease in nourishment intake is clear and thus, are duction in d©evelopment rate upon first exposure. The affect on nourish intake is dose-dependent, with an estimation of 4% diminish in feed intake for every extra ppm of vomitoxin over the dietary concentration of 1.5 ppm (Frobose et al 2015).

The most frequently observed effects of deoxynivalenol consumption in swine are, Vomiting, Growth reduction (anorexia and decreased nutritional efficiency), Protein synthesis inhibition, Gut barrier disruption, Impaired immune function (enhancement and suppression), Decreased reproductive performance

Deoxynivalenol alters the function of intestinal cells and barriers as well as the absorption of nutrients.Bile had the highest levels of deoxynivalenol residues, followed by kidneys and serum. Residues were detected in the liver and in muscle tissue as well. Concerning influence on immunity, trichothecenes in general reduce lymphocyte proliferation, macrophage activity and antibody response to certain vaccinations and influenced immunoglobulin levels.

On Sheep

After 28 days of being exposed to DON (15.6 mg/kg of feed), the average daily growth, hemacytology indicators, or liver function had not changed. However, weight loss (0.6 vs. 2.4 kg/day) has been seen in lambs fed DAS (5 mg/kg of feed) after 34 days. Further weight loss (2.7 vs. 2.4 kg/day) is observed after lambs were given the same dosage of DAS mixed with AF (2.5 mg/kg of feed) for 34 days (Harvey et al 1995).

Poultry

It is well known that broilers and laying hens can tolerate the Fusarium mycotoxin Don. By contrasting Don's absorption, digestive system, and excretion, one can better understand the differential in affectability (Pestka and Smolinski 2005). Trichothecenes have a number of toxic side effects, including oral lesions, growth retardation, unusual feathering, decreased egg production and egg shell quality, regression of the bursa of Fabricius, peroxidative liver alterations, impaired blood blood clotting, leucopoenia and proteinemia, and immunosuppression (Danicke 2007).

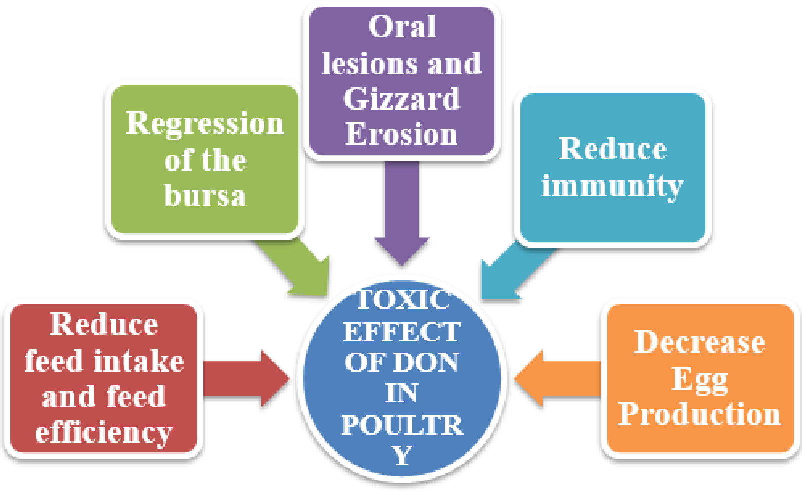

Figure 2: Toxic Effects of DON on Poultry

The majority of experimental studies with poultry show that Don has a highly varied impact on performance. Along with the intoxication with high levels of Don that is only seldom seen, prolonged exposure to lower levels of Don is also of significant interest since it results in economic losses in animal production because of reduced nutrient intake and live weight increase. Yet, many studies do not make a distinction between the effects of dietary intake and Don contamination, it is still challenging to adequately evaluate the direct effects of Don on haematological, clinical-chemical parameters, and resistance(Rotter et al 1996). After reviewing the research on the effects of Don on broiler performance, Danicke et al (2001) came to the conclusion that feeding levels more than 5 mg/kg are necessary for a deleterious effect.

In poultry, DON has been shown to exert immunosuppressive and immunomodulatory effects(Danicke 2007). According to recent studies, DON significantly alters a number of crucial intestinal functions at concentrations between 1 and 7 mg/kg diet(Osselaere et al 2013), including reducing the amount of villus surface area that may be used for ingestion and altering the flexibility of the gastrointestinal system.

Horses:
Contamination of feed with type B trichothecenes like deoxynivalenol is associated with reduced feed consumption, gastrointestinal alterations such as diarrhea and colic that leads to decreased performance have also been observed(Franklin et al 2014).Other symptoms include immunosuppression, poor gut health, decreased tolerance to bacterial and external stressors, and increased susceptibility to diseases (Franklin et al 2014, Sharma 1991).

Management Strategies:
It is critical to use a combination of agronomic strategies to limit the introduction, escalation and spread of fusarium head blight. Best management practices for FHB include the following:

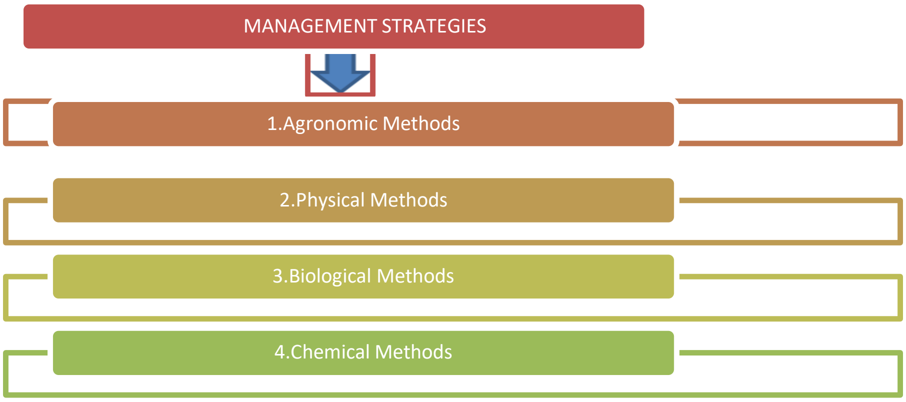

Fig 3: Management Strategies Agronomic Methods

CROP ROTATION
Crop rotation is one of the best cultural-control methods for managing FHB because it significantly reduces the amount of inoculum that is present in the soil (Pirgozliev et al 2003). Growing alternative crops significantly lowers the pathogen level in the soil since most pathogen populations are eradicated in 2-3 years because they lack a host plant for survival. The frequency of crop rotation depends on several factors, including the previous crop, whether the current crop is a suitable host for the virus, and how often it was done before. Shorter rotations may increase the risk of FHB infection. As a result, the prevalence of FHB is highest when the sensitive crop is planted frequently during the rotation regime. Research indicates that when wheat was developed following maize, grain don levels were high (Schaafsma et al 2001). By reducing the amount of local inoculums while planting wheat following soybean may be helpful (Dill-Macky and Jones 2000).

Tillage
Tillage, often known as soil cultivation, is a traditional agricultural activity. To manage FHB, soil cultivation can be a useful strategy. Studies have looked into no-tillage practises, which leave agricultural leftovers exposed. According to Sipila et al (2012), no-tillage management may be a method for stabilising the soilborne inoculum of Fusarium. According to several studies, tillage lowers the levels of pathogens and DON in the soil (Peigne et al 2014). According to a scientific study, the most efficient way to remove crop residues from the soil surface is to use a plough with a mouldboard to amend the soil and make it possible to bury plant remains from the previous crop. Implementing a mouldboard-equipped plough reduces the usual DON compound in wheat grain by 337% (Klix 2007).

Seeds and date of Sowing
The planting date is crucial in a fungal attack since the flowering season is the primary target. Keeping in mind the importance of early planting, managing the sowing date has demonstrated to be essential for FHB control in barley and wheat crops (Choo et al 2014). The proper planting date can also affect a crop's resistance to fungal diseases. Using high quality seed material is essential for preventing the appearance of pathogenic organisms, such as Fusarium spp. and their metabolites, throughout plant development.

Use of resistant cultivars

An efficient management tactic to lessen the threat of mycotoxin in wheat is the use of genetic variants that are more resistant to Fusarium sp. The degree of mycotoxin contamination and the sensitivity of various wheat varieties to Fusarium may vary. Transgenic resistance against toxigenic fungi or their toxins may be increased in three primary ways: increasing resistance to insect attack, triggering mycotoxin elimination pathways, and lowering mycotoxin buildup by interfering with the biosynthesis route (Steiner et al 2017).

Sort I—resistance to disease—and Sort II—resistance to the spread of the pathogen within the head—have been described as two sorts (components) of cereal head resistance to invasion with Fusarium spp. (Mesterhazy 1995). Sorts III and IV, which include plant resilience to contamination and the presence of deoxynivalenol and other auxiliary metabolites, (Kluger et al 2015) as well as sort V, which is resistance to the accumulation and corruption of mycotoxins in grain by changing them into non-toxic derivatives or by blocking the biosynthesis of poisonous metabolites, are also well known (Munkvold 2003).

Biological Methods

FHB is a suitable target for biocontrol since contamination only affects heads during and for a short time after flowering (Xu and Nicholson 2009).The proliferation of FHB in wheat has been controlled through the use of biological control (Luz et al 2003).

DON can largely be converted into 3-epi-DON by Devosia mutans 17-2-E-8 microorganisms isolated from agricultural soil (He et al 2015). 3-epi-DON is less toxic than DON and 3-keto-DON. The Don content in malting wheat grain testing was reduced by LAB, Pediococcus acidilactici, Lactobacillus sakei, and Pediococcus pentosaceus strains in MRS by 47 percent, and P. acidilactici and P. pentosaceus KTU05-8 ZEA substance by 37-38 percent, according to studies (Juodeikiene et al 2018). Biocontrol must be used in conjunction with excellent rural practices in post-harvest yield management in order to reduce the amount of mycotoxins (Kagot et al 2019).

Chemical Methods:

As part of an integrated management plan for FHB, fungicides can be applied. Given that F. graminearum may colonize in wheat heads both intracellularly and intercellularly, For a fungicide to be effective, it must be persistent and able to move through head tissue (Brown et al 2010). FHB incidence and DON buildup in field conditions can be significantly reduced with good management and timely fungicide application (Lehoczki-Krsjak et al 2010).

A number of foliar fungicides have been utilized to manage FHB in a few regions and are connected around the period of wheat flowering. In numerous regions, fungicides are once in a while utilized for FHB control since of high cost, variable adequacy, and the sporadic nature of FHB plagues. Investigate continues to recognize fungicides that are more viable for the control of FHB. Many commercial fungicides that are routinely utilized for cereal seed treatment moreover decrease the chance of Fusarium seedling scourge. Triazoles, a kind of chemical fungicides in the demethylation inhibitor (DMI) fungicide group that suppresses FHB symptoms and lowers mycotoxin concentrations, are the most effective fungicides (Edwards et al 2011, Paul et al 2010). The most effective fungicides for preventing FHB in wheat, according to reports, are tebuconazole, metconazole, prothioconazole, and benzimidazole (Pirgozliev et al 2002, Paul et al 2008).

Conclusion

Don is a mycotoxin that affects essential intestine activities and reduces resistance to enteric pathogens, making its regulation in food essential as it increases the risk of developing other stomach-related disorders. It should be noted that utilising a single technique to decrease the spread of mycotoxin in cereal grains is not particularly effective in light of research findings. Utilizing a variety of strategies in this way, with a focus on prevention, starting with agrotechnical strategies limiting the source of the primary disease, such as proper soil preparation for development, suitable crop rotation with the use of catch crops, selection of cultivars with a high level of resistance to Fusarium spp. disease, to the use of resistance inducers, such as biopreparations based on antagonistic microorganisms, endophytes, and naturally occurring active ingredients It's crucial to create the best conditions possible for grain storage following harvest.

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