NORTHLAND NATURALLY
FIRST REGION OF NEW ZEALAND

Northland Pastoral Extension Research Stocktake

Animal Health: Mycotoxins and Respiratory Disease in Northland

Contents

1.0 Hyperthermia in Cattle Associated with Tall Fescue (Festuca Arundinacea)

Authours: EO Brookbanks, KC Bell, D Fraser, MP Kearns, RJ Sutherland
New Zealand Veterinary Journal 33(4), 57-58, 1985

Abstract

In recent years there have been several reports from the United States of America describing a heat stress syndrome in cattle associated with the consumption of tall fescue (Festuca arundinacea). One of the most comprehensive reports was in 1982 when Hammond et al. described a condition in cattle they called "tall fescue summer toxicosis." This was characterised by increased rectal temperature, increased respiration rate and excessive salivation. A syndrome of hyperthermia has occurred in New Zealand for at least seven years. The first published report described cases occurring in the Bay of Plenty and called the disease "idiopathic bovine hyperthermia" (IBH). By early 1984 it became apparent that bovine hyperthermia was prevalent north of Auckland City and was causing concern to many farmers and veterinarians. We carried out an investigation in April 1984 and visited seventeen herds in five counties for the purpose of collecting information on the disease and specimens for laboratory examination. These herds were reported to us by veterinary practitioners as herds known to have affected cattle. Eleven of the herds were in Rodney County, three in Whangarei County and one each in Otamatea, Hobson and Bay of Islands Counties.

This 1985 article reported work done by MAF Animal Health Division veterinarians, Brookbanks located at Pukekohe, Kearns and Bell at Whangarei, Fraser at Kaikohe and Sutherland at the Whangarei Animal Health Laboratory.

Their work showed an association of hyperthermia/heat stress in cattle in northern New Zealand with the presence of tall fescue on farms, and concluded that the condition was likely to be the same as "tall fescue summer toxicosis" reported from the United States. At that stage it was not recognised that the disease was due to a fungal toxin (mycotoxicosis) produced by endophyte fungi growing in wild tall fescue and also in commercial perennial ryegrasses. Work elsewhere identified the problems of ryegrass staggers, heat stress and fescue foot, arising from endophytes in these grasses. The endophytes and their toxins had the useful survival trait for the grasses of protecting them against insect damage, particularly Argentine Stem Weevil.

However, the following work by Keogh and others was conducted in Northland and illustrates the production losses in dairy cows.

2.0 Performance of Dairy Cows Grazing Pastures With or Without Ergovaline and Lolitrem B

Authors: RG Keogh, M Blackwell, P Shepherd
Proceedings of the New Zealand Society of Animal Production 59(), 254-257, 1999

Abstract

Ergovaline and lolitrem B are alkaloid produced by Neotyphodium endophytes in ryegrass. These toxins are associated with poor animal performance in many situations but influences on milk production by dairy cows had not been determined in NZ except for short-term trials. An on-farm trial was set-up at Te Hana to measure milk production responses in 2 groups of 16 cows which were maintained on a) ryegrass-based pastures which contained wild-type endophytes which produced ergovaline and lolitrem B [+Ev] or on b) ryegrass pastures that were either free of endophyte or contained a novel endophyte which did not produce ergovaline or lolitrem B [-Ev]. The trial ran from October 1997 till mid-April 1998 and milk production was recorded for each cow at each milking for 10 consecutive days per month culminating in a herd test. There was no difference in milk production in October and November, but a difference of 25% developed in December in favour of the -Ev group and substantial differences in production were maintained until the trial was terminated. Effects of ergovaline on cow performance are discussed in relation to environmental and behavioural factors.

This work was extended to “A three-year investigation of the performance of spring-calving dairy cows grazing ryegrass-based pastures of low or high endophyte toxin status in Northland. Keogh RG, Blackwell MB. Proceedings of the New Zealand Grasslands Association 63: 209-214, 2001. In this paper the authors recognise that the advantages of low endophyte toxin pastures can only be sustained as long as their low toxin status is maintained. This depends on keeping the rate of ingress of ryegrass with wild-type endophytes to a low level, a task which requires a good understanding of the processes by which re-infestation occurs. Seed-heads on endophyte-free ryegrass are grazed by cows, but those on wild-type ryegrass are not. Thus removal of seed-heads before seed-set is one strategy that would slow the rate of ingress of wild-type ryegrass.

Work has steadily proceeded in this fungal toxin field and is well summarised in the Feature Review Series Article By Woodfield DR and Easton HS. Advances in pasture plant breeding for animal productivity and health. New Zealand Veterinary Journal 52(6), 300-310, 2004.

Among the key points in this article is –
The development of non-toxic endophytes that alleviate ryegrass staggers (eg. AR1), heat stress and fescue toxicosis (eg. MaxQ^{TM}) has provided productivity gains in both sheep and cattle.

Relevant extracts from the text of the article include:
The discovery that livestock only suffer from ryegrass staggers when grazing ryegrass infected with fungal endophyte led to the identification of lolitrem B as the major causal factor in 1981.

Intensive screening of endophyte strains from around the world was conducted to offset the good and bad effects of the chemicals produced by the fungi. The first commercial release was 'Endosafe' in 1991, but although this endophyte had low lolitrem levels, it had high concentrations of ergovaline, which causes hyperthermia/heat stress.

A renewed search found strains that were free of ergovaline and related compounds. The first of these strains, AR1, has undergone intensive study of its agronomic, animal safety and animal productivity worth. Sheep and cattle grazing pastures infected with AR1 are free of toxicosis and produce meat and milk at least as well as animals grazing ryegrass free of any endophyte. AR1 is currently available in nearly 20 proprietary ryegrass cultivars and has enjoyed rapid uptake by the livestock industries.

With respect to fescue toxicosis:
Tall fescue is the predominant temperate grass in Southern USA. Livestock grazing tall fescue infected with wild-type endophyte may suffer fescue toxicosis, most commonly observed as severe heat stress in summer. Ergovaline is the causal factor, as it is in some endophyte infected perennial ryegrass. In New Zealand, wild tall fescue growing in fertile waste places produces not only heat stress in summer, but causes 'fescue foot', a gangrenous condition of cattle and other ungulates suffered in winter. This condition only occurs with endophyte-infected tall fescue, and until 2003, all tall fescue seed sold in New Zealand was endophyte-free.

Seed infected with a selected, non-toxic endophyte has been available in the USA as 'Max Q^{TM}' since 1999, and was available in limited quantities in New Zealand and Australia as Max P^{TM} in early 2004.

The references for the above summary are available in the full text of the article in the NZvetJ.

3.0 Other Mycotoxicoses

No specific research has been done in Northland on the non endophyte mycotoxicoses. However the following review papers describe their effects, which are particularly applicable in Northland.

Mycotoxin poisoning in grazing livestock in New Zealand. Towers NR. Proceedings of the New Zealand Society of Animal Production 66, 300-306, 2006.

Abstract

A number of mycotoxicoses including facial eczema, ryegrass staggers, paspalum staggers and zearalenone infertility affect grazing livestock, causing death and reducing productivity. While production losses associated with clinical disease are well recognised, losses associated with subclinical disease are not recognised and most farmers take few or no precautions against the diseases and consequently accept lower productivity levels as 'normal'. For most mycotoxicoses there are no antidotes. Long-term projects, some lasting decades, have led to the development of a number of control measures for particular diseases, especially facial eczema and ryegrass staggers. These measures depend primarily on identifying toxic pastures, or reducing their impact. Under the current funding regimes, where funders seek quick returns, it is unlikely that many of these now widely used control methods would have come to fruition.

The paper Mycoctoxicoses of grazing animals in New Zealand. Smith BL and Towers NR. New Zealand Veterinary Journal 50(3 Supplement), 28-34, 2002. makes the following key points in its abstract.

- Mycotoxicoses are some of the most important diseases of animals grazing pasture in New Zealand, especially in northern areas where the disease, facial eczema, occurs.
- New Zealand scientists have led the world in research on facial eczema and endophyte-related diseases associated with tremor.
- Facial eczema (pithomycotoxicosis) was one of the first mycotoxicoses to be studied systematically and successful methods for its control now exist. Toxicity is caused by the concentration of sporidesmin in the biliary system and its redox cycling which leads to the formation of toxic free-radicals.
- Zinc salts are capable of preventing facial eczema. Their efficacy and safety for farm use has been demonstrated and intraruminal boluses containing zinc have been developed for use in sheep and cattle.
- Endophyte-related diseases have received special attention over the last 15 years. It is now recognised that *Neotyphodium* spp and grasses (especially ryegrass and fescue) are an essential symbiosis, making control of these diseases in grazing animals difficult.
- New Zealand research has demonstrated inhibitory effects of zearalenone, from *Fusarium* spp growing on pasture litter, on sheep fertility.

Breeding for resistance to facial eczema is not mentioned in these two abstracts directly, but it has been a successful long-term research and operational strategy to mitigate the effects of sporidesmin in sheep.

For a time acute kikuyu grass poisoning was considered to possibly be due to fungal toxins. It was reported in the letter, “Similarities between so-called kikuyu poisoning of cattle and two experimental mycotoxicoses.” Martinovich D, Mortimer PH, di Menna Margaret E. New Zealand Veterinary Journal, 20, 57-58, 1972. Similar clinical signs and lesions were produced in cattle and sheep dosed experimentally with cultures of *Myrothecium* and *Phoma* spp. However, although the warm, humid weather associated with kikuyu poisoning was favourable to fungal growth, these fungal spp were not found in significant numbers on pasture on which kikuyu poisoning had occurred. The kikuyu toxin is still unknown, but it is now thought to be produced by the plant in response to insect damage, or conditions associated with it. In practical terms, the growing proportion of kikuyu grass in Northland can be managed to reduce the effects of mycotoxicoses in grazing ruminants, which are associated with the temperate species of ryegrass and fescue.

4.0 Respiratory Diseases of Northland Livestock

Serious respiratory problems of cattle in Northland are infrequent and do not differ markedly from those that may occur in other parts of New Zealand. They largely relate to the Bovine Virus Diarrhoea, Infectious Bovine Rhinotracheitis and Bovine Respiratory Syncytial viruses. Motha J, Hansen M, Orr D. Viral aetiologies for bovine respiratory disease. New Zealand Veterinary Journal 45(1), 40, 1997, is a recent review that rather overstates the case with respect to bovine respiratory disease in my view, but there is no denying the major disease, production and reproduction loss effects of BVDV due to its effects on its primary target tissue, the immune system.

Occasionally respiratory problems may arise in calf rearing operations where confinement and poor ventilation appear to result in ammonia gas toxicity. The paper 'Some preliminary observations on the possible relationship between ammonia production from soiled bedding in calf rearing sheds and calf illness. Dewes HF, Goodall G. New Zealand Veterinary Journal 43(1), 37-41, 1995, has interest for Northland mainly due to the second author being a rural clinical veterinarian in Northland (Waipu) from soon after that publication.

Respiratory problems of deer are largely confined to the lungworm *Dictyocaulus viviparus*, which is described in standard texts. The same lungworm species can also be a problem in calves.

Thus respiratory disease has no special affinity for Northland over other New Zealand livestock, except for pneumonia of lambs, which is most severe in this region. It is one of the reasons for the decline of ewe numbers and sheep farming in the region. One Northland researcher, Hugh Black has investigated the risks and causes of lamb pneumonia, together with pneumonia vaccine efficacy during his period of active involvement with the live sheep for slaughter export trade to Saudi Arabia during the 1990's.

Collaboration between researchers has been poor in the lamb pneumonia field, but three of the current leading investigators came together in a recent letter to the New Zealand Veterinary Journal.

Black H, Alley MR, Goodwin-Ray KA. Heat stress as a manageable risk factor to mitigate pneumonia in lambs. New Zealand Veterinary Journal 53(1), 91-92, 2005.

Abstract

The paper by Goodwin et al (2004) which appeared in the August issue of the New Zealand Veterinary Journal highlighted the prevalence and costs to the sheep industry of pneumonia in lambs. The costs are considerable, and the article begs the question "what can sheep farmers do to reduce the effects of pneumonia in lambs?" Goodwin et al (2004) referred to multiple risk factors which have been proposed, including open-mouth panting (West et al 2002), but they commented that evidence to support the role of these was lacking. This is not correct for the major risk factor of heat stress, which may be

observed by farmers and handlers as the behaviour of panting. Open-mouth panting in sheep is not an effort to inhale more air for oxygenation as in exercising humans, rather it is the cooling mechanism by which sheep use respiratory evaporation to lower elevated body temperature.

This letter references most of the recent significant papers on lamb pneumonia in New Zealand, except the review, 'Pneumonia in sheep in New Zealand: an overview. Alley MR. New Zealand Veterinary Journal 50(3) Supplement, 99-101, 2002, which maintains the entrenched Massey position that the acute and chronic disease syndromes are separate entities, while presenting strong evidence that they are interactive. Alley states that *pasteurellae* are the main bacterial agents responsible for lung injury in both forms of pneumonia. This was apparent from the survey by Black H. *Pasteurella* isolates from sheep pneumonia cases in New Zealand. Surveillance 24(3), 5-8, 1997. In this study, approximately 9400 lambs from 75-80 lines (farms of origin) were examined at seven slaughter plants between 5 March and 1 April 1996. *Pasteurellae* of a range of species and serotypes were isolated from 406 of 509 samples collected from active lesions and submitted for culture. *Pasteurellae* are the main cause of pathological interaction of acute and chronic pneumonias of lambs, and cause the fibrinous exudates that result in pleurisy. The lesion rate decreased from Northland to Southland, and the percentage of *P.multocida* isolates was considerably higher in Northland than the other six regions.

Some controversy remains among researchers in the lamb pneumonia field, mainly with respect to the pathological interactivity of the pneumonic lesions, and the role of heat stress as a risk factor on farms. Black has recently reviewed the current understanding of the lamb pneumonia syndrome in the popular press. Rural News, 22 May 2007 p35 and 37. The text of this article follows.

'Drive lambs easier or kill them.'
With a salt breeze in his nostrils, sunlight dancing on the waters, no flies buzzing and the prospect of a good lunch, shipboard vet Hugh Black was only ever mildly reluctant to perform post mortems on sheep that died in his care.
These were the early-1990s boom days of the Middle East live-sheep-for-slaughter trade, and Black, now a senior vet with AgriQuality, Northland, was then a technical advisor to MAF.
Sheep pneumonia remains a killer in New Zealand and the lessons of those seagoing years need to be learned by a new generation of shepherds and farmers for better lamb management, Black argues.

Aboard ship bound for the Middle East, heat, humidity and/or poor air flows were all in a days work, sometimes leading to heat stress in animals which then died of pneumonia. This writer had the opportunity to look at thousands of dead lambs and to examine the lungs of surviving vaccine-trial lambs at slaughter in Saudi abattoirs. Such large numbers were not available to land-based researchers.

A fair conclusion is that if lambs are never forced to pant they will probably not get pneumonia. So it is distressing to see a usually young shepherd driving a mob of sheep – often from a farm-bike or ATV – so hard the lambs begin to pant.

In the absence of an effective vaccine the most valuable tool the farmer has to mitigate pneumonia in lambs is to manage heat stress. Such management will do much to reduce financial losses from slowed growth rates, pleurisy downgrades and on-farm mortality from pneumonia.

Further farm studies to develop control strategies to mitigate pneumonia in lambs should focus on management practices relating to aggregation and heat stress, such as mustering and droving procedures, yard handling and other aspects of stockmanship, together with pasture composition and shade provision, for susceptible animals.

Heat stress has the clear clinical sign of panting, because sheep cool themselves by water evaporation from the respiratory tract. When the panting gets to the stage of open mouths, it is correlated with a body temperature of about 41C.

Sheep, and other animals, begin to die of heat stroke when their body temperatures reach 43C, so the stress of open-mouth panting is clear. Sheep are not panting to get more oxygen, they are panting to cool down. When farmers see lambs panting during droving they should slow down. In fact lambs, and all sheep, should be driven slowly to avoid exercise-induced heat stress. Mustering slowly on cool, cloudy, low humidity and/or windy days is good stockmanship. If the droving distance is long, allow time for lambs to rest.

During the shipboard days four main findings expanded our understanding of lamb pneumonia beyond land-based studies.

1. The lamb pneumonia lesions were pathologically interactive between acute and chronic states, and the confusion of the many names (enzootic pneumonia, virus pneumonia, Southland pneumonia, chronic non-progressive pneumonia, acute fibrinous pneumonia, *Pasteurella* pneumonia, pleurisy) used to describe the syndrome in New Zealand were all referring to the same condition – pneumonia. In particular it is helpful to move on from the thinking that categorises chronic and acute pneumonia as separate.

It is a complex syndrome. The risks, causes and the pathological lesions themselves are interactive and may result in a range of outcomes, including recovery with or without slowing growth rate, recovery with or without residual pleurisy, or in failure to recover, with death from either acute or chronic progressive lesions.

2. One of the bacteria involved, Pasteurella multocida, was more important than had been thought. This has been confirmed by Blacks land-based studies.

3. The commercially available pneumonia vaccines do not reduce either mortality or the morbidity of lesions at slaughter. This has been confirmed by Massey University land-based studies.

4. Most importantly, heat stress is a putative (ie supposed), but highly probable, probably pivotal, risk factor for lamb pneumonia that explains the on-farm statistically recognised risk factors of lamb shearing at weaning, large farms and non fine-wool sheep. Lamb shearing involves both aggregation and the opportunity for exercise-induced heat stress at mustering. Larger farm sizes mean longer mustering distances for yarding with heat stress panting if stock are moved too quickly. Ewes other than fine-wool breeds means British breeds, and thus heat-susceptible sheep.

Why are the lessons about pneumonia not being passed on to farmers? Here are some possible reasons:

1. Collaboration of pneumonia researchers is not well co-ordinated in spite of the excellent efforts of MWNZ to facilitate it.
2. Research groups have difficulty relating the observations between shipboard and farmed lambs.
3. The shipboard observations are putative, and difficult to prove statistically, because they were made during pneumonia vaccine trials, which were controlled for efficacy but not for risk factors such as heat stress.
4. There is sometimes a long lag between research findings and communication to farmers for application.

The text of this review may be diagrammatically represented in the causal web linked boxes below.

Causal Web of NZ Lamb Pneumonia –
The live sheep trade identified the factors in bold.