Characteristics of the grazing and farm management of broodmares on commercial Thoroughbred stud farms during spring

J Bengtsson[2], CW Rogers[1], PJ Back[1], U Emanuelson[2], J Roca[1], EK Gee[1] and CF Bolwell[1]

[1]*School of Veterinary Science, Massey University, Private Bag 11 222, Palmerston North, New Zealand.* [2]*Department of Clinical Sciences, Swedish University of Agricultural Sciences, Uppsala, Sweden*

Corresponding author: Email: c.w.rogers@massey.ac.nz

Abstract

Thoroughbred broodmares in New Zealand are at greater odds of exposure to *Leptospira* than racehorses, possibly as a result of aspects of the on-farm pasture-based management. To identify biologically plausible risk factors cohorts of broodmares were prospectively followed on four Thoroughbred stud farms for a five-week period during the 2017-2018 season. Up to three cohorts of mares within each group of mares identified at the start of the study as empty (not in foal), in-foal, or mares having just foaled (with foal at foot) were followed on each farm and measurements made of pasture dry matter (DM) on offer, paddock location, mare cohort structure and farm management. The farm with stallions had a greater number of changes in mare cohort membership (2 (1-2) vs. 0 (0-1), P=0.001). The total pasture DM on offer was least for empty mares compared to in-foal mares, and mares with foals at foot (1483 (1157-2380) vs. 2070 (1499-2534) vs. 2299 (1390-3196) kg DM/ha, P=0.009). Pregnant mares had the greatest stocking density 4 (2 -6) mares/ha, due to use of small foaling paddocks. The low pasture DM on offer and high stocking rate for empty mares may provide a mechanism for exposure to environmental sources of *Leptospira*.

Introduction

A recent cross-sectional study of Thoroughbred broodmares and race horses in training identified an industry sero-prevalence for *Leptospira* of 25% (95% CI 21%-29%), with the odds of exposure to *Leptospira* being higher for broodmares compared to racehorses, possibly due to the increased risk when grazed alternately with sheep (Bolwell et al. 2017a) (C Bolwell unpublished data). Despite the high sero-prevalence in the broodmare population, very few cases of Leptospirosis are reported in horses in New Zealand. The sero-prevelence survey also highlighted the current lack of detailed data of the farm-level management of broodmares within New Zealand, and thus, the ability to identify farm-level risk factors or precise hypotheses for likely methods of exposure.

New Zealand has an equine industry that is pasture based (Bolwell et al. 2017b, Gee et al. 2017) and this provides a set of production variables that may influence the opportunity for mares to be exposed to environmental sources of *Leptospira.* The registration requirement for Thoroughbred mares to be bred by natural mating ensures that during the breeding season there are multiple movements of mares between farms. This provides significant concentration of mares, from multiple farm sources, on relatively few properties and significant grazing pressure on these properties during the breeding season. The large between-farm movement of mares during the breeding season has been previously identified as a potential mechanism for the rapid dissemination of an infectious agent and a biosecurity risk within the New Zealand Thoroughbred industry (Rosanowski et al. 2013, Rosanowski et al. 2014, Rogers & Cogger 2010). It is therefore important to understand the pasture management of Thoroughbred mares during the breeding season, to identify pasture and horse management variables that may be associated with the exposure to environmental sources of *Leptospira*.

This paper examined on-farm pasture management of cohorts of Thoroughbred broodmares during the breeding season to identify biologically plausible management variables for exposure to *Leptospira*.

Materials and methods

The study population consisted of four commercial Thoroughbred breeding farms identified as boutique (farms without a stallion, n=3 farms) or commercial (with a stallion, n=1 farm). Within each farm up to three categories of mares were identified; either empty (not in foal), or in-foal, or mares with foals at foot (just foaled but not pregnant). On each farm, up to three cohorts of mares within each category were followed prospectively during a five-week period during the spring of the 2017-2018 breeding season. Where possible, the recruitment of the mare cohorts was based on cohorts containing at least one mare identified in the previous breeding season as being seropositive for one of the five *Leptospira* serovars (*Ballum, Hardjobovis, Pomona, Copenhageni* or *Tarassovi)* (Bolwell et al. 2017a)

At the start of the study the stud farm managers were interviewed and data on the general farm layout and management were obtained via a face-to-face questionnaire, consisting of 36 open, closed and multiple-choice questions. For each mare data were obtained of the mare's age and breeding history from an online database (New Zealand Thoroughbred Racing www.nzracing.co.nz).

For each cohort, on-farm measurements were made weekly of the total pasture dry matter (DM) on offer and the pasture DM of the lawns (areas preferentially grazed by the horses) and the pasture DM of the roughs (latrine areas with sward height >four cm) using a rising plate meter (Bengtsson 2018). Data were also collected on the paddock location, and mare cohort membership. Data on paddock location (within farm), topography (size and composition), terrain/soil-type, drainage, location of feeding areas, water sources, opportunity for contact with other animals, wildlife habitats, presence of pests, location of manure or burn pile, animal movements and weather conditions were collected weekly and recorded on a *pro forma* recording sheet.

Data were collated and stored in a customised database. Data were initially tested for normality (Shapiro Wilks test). Summary data are presented as median and inter-quartile range (IQR) and differences between groups were tested using the Kruskal Wallis test. All analysis was conducted using Stata version 12 (StataCorp LP, College Station, TX, USA).

Results

All farms co- grazed or cross-grazed the horses with either sheep or cattle. There were large movements of mares on and off the farms during the breeding season, with the boutique farms sending 80-100% of their resident mares to other farms for breeding (Table 1). The greatest movement of mares were associated with the commercial farm. While only 15% (20/130) of the resident mares on this farm went to other farms for breeding, there was an almost two-fold increase in the on-farm mare population during the season, due to mares sent to the farm for breeding.

The farm standing a stallion (commercial farm) had greater changes in mare cohort membership (2 (IQR 1-2) vs. 0 (IQR 0-1), P=0.001) than did boutique farms, but there was no difference in the number of paddock rotations for all classes of mares. On the commercial farm, pregnant mares experienced 2 (2-2) changes in the cohort prior to entering the foaling paddock. Within the foaling paddock, there were another 2 (IQR 2-3) changes in cohort (mares waiting to foal and managed in small paddocks under floodlights). After foaling and then mating, the mares remained in the same cohorts until a confirmatory pregnancy scan (42 days positive pregnancy test) and returning to the home farm. Empty mares remained in cohorts of empty mares until a positive pregnancy scan and had 3(IQR3-3) changes in cohort membership.

The total pasture DM on offer and the pasture DM within the areas identified as lawns and the roughs are presented in Table 2. Across all farms the total pasture

Table 1 Descriptors of four Thoroughbred stud farms and the horse numbers, stock class and grazing management during the 2017 to 2018 breeding season. Data presented as median and inter-quartile range (IQR).

		Farm 1	Farm 2	Farm 3	Farm 4
Size (ha)		121+40	86	160	20
Resident mares (n)[1]*		100-130	28	20	12
Outside mares on farm for foaling (n)[2]*		120-200[1] (breeding 9 weeks)	20[2] (3 weeks)	0	0
Resident mares sent to other studs (n) *		20	24	20	12
Total mares on property during spring (n) *		250-300	4-48	0-20	0-12
Empty mares per paddock	n(IQR)	4 (4 – 8)	10 (9-10)	8 (7-9)	3 (3-3)
	ha(IQR)	1.9 (1.5-2)	7(6.5-7)	6 3 (6.3-6.3)	1.3 (1.3-1.3)
	n/ha(IQR)	2.6 (2.4-5.8)	1.4(1.3-1.4)	1.3 (1.1-1.4)	2.3 (1.5-2.3)
Pregnant mares per paddock	n(IQR)	8 (6-19)	8 (7-8)	3 (2-4)	6 (4-8)
	ha(IQR)	1.4 (0.8-5)	6 (1.9-7)	2.7 (0.35-4)	1.5 (1.5-1.5)
	n/ha(IQR)	5.9 (4 -7.5)	1.4 (1.1-3.2)	2.8 (1.4-6.2)	4 (2.8-4)
Mares with foals per paddock	n(IQR)	3 (2-4)	3 (2-3)	-	1 (1-2)
	ha(IQR)	3 4(1-3.4)	2.5 (2.1-2.5)	-	0.43 (0.3-0.48)
	n/ha(IQR)	1.7 (0.6-3)	1.2 (0.9-1.2)	-	3.3 (2.0-4.6)
Mares in foaling paddocks	n(IQR)	2 (2-2)	-	-	-
	ha (IQR)	0.8 (0.8-0.8)	-	-	-
	n/ha(IQR)	2.5 (2.5-2.7)	-	-	-
Paddock rotation interval for Empty mares *		1-6 months	1-6 months	Set stocked	2-4 weeks
Paddock rotation interval for Pregnant mares *		2-4 weeks	1-6 months	Set stocked	2-3 weeks
Paddock rotation interval for Mares with foals *		2-4 weeks	2-4 weeks	Set stocked	2-3 weeks
Paddock rotation interval for Livestock *		Co- and cross-graze with horses	1-6 months co-grazing with horses	Set stocked and co-grazing with horses	2 weeks to 6 months co-grazing with horses
Stallions (n) *		3	0	0	0
Racing horses (n) *		0	0	0	20
Spelling horses (n) *		30-60	2-3	0	6
Weanlings (n) *		60	20-22	15	7
Yearlings (n) *		40	6-8	7-8	5

*These data are from the survey with the stud manager

[1]Mares sent to the farm for foaling, mated with the stallion and return to home farm after confirmatory pregnancy test

[2]Mares sent to the farm for foaling and then sent to another farm to be mated.

Table 2 Pasture dry matter (DM) (kg DM/ha) and pasture DM/ha for lawns and roughs on the four thoroughbred stud farms followed during the 2017-2018 breeding season. Data is separated into the mares management groups of Empty, Pregnant, Foaling paddock and Mares with foals at foot.

	Farm 1	Farm 2	Farm 3	Farm 4
Empty				
Total DM (kg DM/ha) (IQR)	1670 (1385-2933)	1344 (1001.9-1736)	1176 (1140-1468)	911 (792.5-1132.2)
Pasture DM/ha for Lawns (IQR)	1401 (1184-2390)	1164 (940-1411)	1180 (1153-1316)	879 (652-974)
Pasture DM/ha for Roughs (IQR)	2523 (2101-4834)	2915 (2277-3478)	1838 (1780-2459)	1074 (1005-1785)
Pregnant				
Total pasture DM (kg DM/ha) (IQR)	1444 (1369.2-2202.7)	2258 (1795-2372)	1993 (1645-2601)	1144 (1124-2427)
Pasture DM/ha for Lawns (IQR)	1343 (800-2922)	1801 (1411-1969)	1759 (1558-2027)	1048 (911-1843)
Pasture DM/ha for Roughs (IQR)	3228 (1774-4845)	3823 (2783-4171)	3502 (2859-4181)	2317 (2201-3644)
Foaling paddock				
Total pasture DM (kg DM/ha) (IQR)	2045 (2001-2854)			
Pasture DM/ha for Lawns (IQR)	1827 (1527-2017)			
Pasture DM/ha for Roughs (IQR)	2960 (2638-3818)			
Mares with foals				
Total pasture DM (kg DM/ha) (IQR)	1610 (1408-2159)	1962 (1827-2290)	- -	3222 (2893.9-4517.4)
Pasture DM/ha for Lawns (IQR)	1338 (1121-1827)	1690 (1195-1706)	- -	3281 (3196.7-3997.3)
Pasture DM/ha for Roughs (IQR)	2617 (2496-2975)	3465 (3212-3697)	- -	4898 (4666.1-5161.2)

DM on offer was least for empty mares compared to in-foal mares, and mares with foals at foot (1483 (1157-2380) vs. 2070 (1499-2534) vs. 2299 (1390-3196) kg DM/ha, P=0.009). Pasture DM of the lawns were also lowest for the empty mares (1292 (1058-1606) vs. 1798 (1342-2022) vs. 1830 (1390-3196) kg DM/ha, P=0.004). Pregnant mares had the greatest stocking density 4 (2 -6) mares/ha, due to use of small foaling paddocks.

Discussion

The high sero-prevalence of Thoroughbred broodmares for *Leptospira* demonstrates a greater need to describe the management and productive lifecycle of the Thoroughbred broodmare to understand the opportunity for exposure to environmental sources. These environmental sources, as observed in other livestock species, are likely to be related to the pasture based management system, and exposure to urine from shedding individuals , either from co-specifics or species used for co- or cross grazing (Dreyfus 2013).

On commercial farms, the number of broodmares on the farm typically increases up to three-fold during the breeding season, as the stud managers attempt to ensure each stallion covers a minimum of 75 mares. During spring the broodmare numbers on the boutique farms were reduced significantly and these mares were mixed as part of management cohorts on the commercial farm. The greatest mixing and changing of cohorts occurred with the pregnant mares as they progressed through the production cycle. The stocking density (mares/ha) was greatest for the pregnant mares, though this is generally attenuated with the greater pasture DM on offer to this stock class (Rogers et al. 2017).

All pregnant mares also passed through the foaling paddocks and these were associated with high stocking densities. The use of foaling paddocks, rather than foaling looseboxes, is a unique feature of the New Zealand equine industry. In general, the use of a foaling paddock, rather than a loose box, has been identified as lower risk of infection for the neonate (Rogers et al. 2007). Most studs regularly remove faecal and placental material from the foaling paddocks because of the high concentration and throughput of mares during the season. It is therefore unlikely that this area, even with the changing of mare cohorts, would provide a focus for exposure to *Leptospira*.

At the start of the breeding season many studs have the empty mares on a rising plane of nutrition in an attempt to promote the early onset of oestrous. However, prior to this short ‘flushing’ period, empty mares are often managed on pasture with pasture DM/ha significantly lower than other classes of stock. The greater grazing pressure in these cohorts, during winter and spring, indicates that this may provide an increased opportunity for exposure to pasture based environmental sources of *Leptospira*. Some caution may be needed when interpreting the absolute, rather than the relative, pasture DM/ha values as the spring monitored in this study (2017-2018 breeding season) was particularly wet, with higher than average rainfall and therefore lower than average pasture growth.

Recent work has demonstrated the persistence of *Leptospira* within the environment. The moderate temperate climate in the regions where the majority of stud farms in New Zealand are located (South Auckland, Waikato, Central Districts) may provide an ideal pasture environment to sustain the *Leptospira*. Cross grazing with sheep increases the odds of a broodmare being sero-positive for one of the serovars of *Leptospira*. Many farms will use cattle and sheep to clean up the pasture after the breeding season (autumn to early winter), providing a potential mechanism for the introduction of *Leptospira* to the pasture environment via shedding in urine.

The pattern of breeding provides the greatest concentration of horses during the spring. During periods of intensive grazing pressure, horses start to graze in the roughs, and there is a reduction in the pasture DM and proportion of paddock identified as roughs (latrine areas) (Rogers et al. 2018). Thus, greater mare density and grazing pressure encourages mares to graze pasture lower, and exposure to pasture that were latrine areas, and thus greater probability of containing *Leptospira*. The reduction is sward height (in both lawns and roughs) could also be associated with greater chance of exposure to *Leptospira,* as most farms used cattle or sheep to co-graze or cross-graze pasture. Infection across species has been identified with other production animals, and the vaccination status of dairy beef or weaner beef cattle used for cross grazing on these properties were unknown.

Conclusion

These data indicate that the change in cohort composition, intensive stocking rates and relatively low pasture cover (pasture DM/ha of lawns) during the wetter season of the year (spring) provide a biologically plausible focus of events at farm-level to provide broodmares with exposure to *Leptospira*. Further prospective testing of sero-prevalence in association with measurement of pasture data is required to test the strength of these associations and provide potential management tools to reduce the risk of exposure.

References

Bengtsson J 2018. Grazing and farm management of broodmares as an exposure to leptospirosis on commercial equine properties in New Zealand. Faculty of Veterinary Medicine and Animal Science. Uppsala, Swedish University of Agricultural Science.

Bolwell CF, Benschop J, Rogers C, Collins-Emerson JM, Gee EK, Wilkinson D, Forsyth S 2017a. Sero-prevalence of Leptospirosis in horses in New Zealand. In Heuer, C (Ed.) 10th International Leptospirosis Society Meeting. Palmerston North, New Zealand.

Bolwell CF, Rogers CW, Gee EK, Rosanowski SM 2017b. Commerical equine production in New Zealand 3: The racing and sport industries. Animal Production Science**:** http://dx.doi.org/10.1071/AN16753.

Dreyfus A 2013. Leptospirosis in humans and pastoral livestock in New Zealand. PhD. Institute of Veterinary Animal and Biomedical Sciences. Massey University, Palmerston North, New Zealand.

Gee EK, Rogers CW, Bolwell CF 2017. Commerical equine production in New Zealand 2:Reproduction and breeding. Animal Production Science**:** http://dx.doi.org/10.1071/AN16728.

Rogers CW, Cogger N 2010. A cross-sectional survey of biosecurity practices on Thoroughbred stud farms in New Zealand. New Zealand Veterinary Journal*,* 58**:** 64-68.

Rogers CW, Gee EK, Back PJ 2017. Pastures and supplements in New Zealand commercial equine production systems. In Rattray, PV, Brookes, IM & Nicol, AM (Eds.) Pasture and supplements for grazing animals. New Zealand Society of Animal Production.

Rogers CW, Gee EK, Back PJ, Van Son S, Hirst RJ, Pomroy WE 2018. Pasture use and management in commercial equine production systems. New Zealand Journal of Animal Science and Production 2018 78: 40-44.

Rogers CW, Gee EK, Firth EC 2007. A cross-sectional survey of Thoroughbred stud farm management in the North Island of New Zealand. New Zealand Veterinary Journal 55**:** 302-307.

Rosanowski SM, Cogger N, Rogers CW, Benschop J, Stevenson MA 2013. An investigation of the movement patterns and biosecurity practices on Thoroughbred and Standardbred stud farms in New Zealand. Preventive Veterinary Medicine 108**:** 178-187.

Rosanowski SM, Cogger N, Rogers CW, Bolwell CF 2014. The prevalence and risk factors for respiratory disease on Thoroughbred and Standardbred stud farms in New Zealand. Proceedings of the New Zealand Society of Animal Production 74**:** 5-10.