An introductory survey of helminth control practices in South Africa and anthelmintic resistance on Thoroughbred stud farms in the Western Cape Province

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ABSTRACT

Fifty-one per cent of 110 questionnaires, designed for obtaining information on helminth control practices and management on Thoroughbred stud farms in South Africa, were completed by farmers during 2000. The number of horses per farm included in the questionnaire survey ranged from 15 to 410. Foals, yearlings and adult horses were treated with anthelmintics at a mean of 7.3 ± 3.0, 6.6 ± 2.7 and 5.3 ± 2.3 times per year, respectively. An average of 3.4 different drugs were used annually, with ivermectin being used by most farmers during 1997–2000. On 43 % of farms the weights of horses were estimated by weigh band and 45 % of farmers estimated visually, while both were used on 7 % of farms and scales on the remaining 5 %. Doses were based on average group weight on 50 % of the farms and on individual weights on 46 %. Forty-three per cent of farmers performed faecal egg count reduction tests (FECRT). Most farmers rotated horses between pastures and treated new horses at introduction. Faecal removal was practiced on 61 % of farms and less than 50 % of farmers used alternate grazing with ruminants. Faecal egg count reduction tests were done on 283 horses, using oxibendazole, ivermectin and moxidectin on 10, 9 and 5 farms, respectively, in the Western Cape Province during 2001. While the efficacy of oxibendazole was estimated by FECRT to range from 0–88 % and moxidectin from 99–100 %, ivermectin resulted in a 100 % reduction in egg counts. Only cyathostome larvae were recovered from post-treatment faecal cultures.

Key words: anthelmintic resistance, gastrointestinal nematodes, horse, South Africa, thoroughbred, worm control.

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INTRODUCTION

Worldwide, helminth control practices in the modern horse industry are focussed primarily on the control of cyathostomes (also known as small strongyles). The extensive use of anthelmintics at intervals shorter than the prepatent period has led to the demise of the large strongyle, *Strongylus vulgaris*, as the main parasitic threat to horses[12,27]. However, total eradication of horse helminths is highly unlikely[12,20], as evidenced by escalating resistance in cyathostome populations. Helminth control practices have been based largely on the traditional indiscriminate use of anthelmintics every 2 months[12], while high treatment frequency and prolonged use of the same chemical group are 2 of the reasons for the development of resistance, for example benzimidazole (BZ) resistance in cyathostomes[16]. Anthelmintic resistance (AR) is a global problem with reports of resistant cyathostome populations from countries such as Australia[16,30], Britain[8], Denmark[4], the Netherlands[1] and the USA[25,26]. The status of anthelmintic resistance in horses in South Africa is poorly researched and our current body of knowledge is based on 2 studies in which 1 reported BZ resistance[5,28]. With reports of AR increasing and the catastrophic effect that it can have on the horse industry, more emphasis is placed on the development and use of integrated control strategies that depend less on anthelmintics but still prevent helminth-related diseases[9,10,12,22]. The main aims of an integrated helminth control programme would therefore be: 1) reduce the number of infective 3rd-stage larvae on pasture through practices such as pasture management (*e.g.* alternate grazing with ruminants) and faecal removal[11,16], 2) reduce the level of pasture contamination through selective treatment of resident horses[7,17], 3) treating both new and visiting horses on arrival and keeping them separate for at least 48 hours[16,27], and 4) regular assessment of management practices and anthelmintics that are used[4,25].

In South Africa, Thoroughbred stud farms are located mainly in the Western Cape (winter rainfall) and KwaZulu-Natal (summer rainfall) provinces. There are no data on the prevalence of AR in either of these provinces and there is only little information about helminth control practices on Thoroughbred stud farms in South Africa. The information will facilitate the evaluation of management practices and the potential risk of AR development in South Africa's horseracing industry. The aims of the present study were to conduct a questionnaire survey of current helminth control practices on Thoroughbred stud farms in South Africa and to test for the occurrence of AR in horses kept under intensive farming conditions in the Western Cape.

MATERIALS AND METHODS

Questionnaire

A questionnaire was developed to obtain information from Thoroughbred stud farms on their helminth control and management practices. In 1999 a list of possible participants was obtained from a large horse-feed producer. In the selection process preference was given to larger horse stud farms (farms with at least 10 horses per farm). One hundred and ten farms were selected. They were distributed predominantly in the Western Cape and KwaZulu-Natal.

Initially, questionnaires were posted to all 110 farms in January 2000 and a 12-month response time was allowed, till January 2001. An explanatory letter setting out the aims thereof and a pre-paid

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Table 1. **Characteristics of 10 Thoroughbred stud farms, their anthelmintic treatment practices and grazing management.**

Farm no.	Total no. of horses	Age of foal at first deworming (weeks)	No. of treatments per annum			Anthelmintics used from group*					Treatment of introduced horses	Practise faecal removal	Same paddocks for grazing every year
			Weanling	Yearling	Adult	I	II	III	IV	V			
1	200	4	12	12	12	*		*	*		Yes	Yes	Yes
2	120	12	3	2	2			*	*	*	Yes	Yes	No
3	250	8	3	3	4		*	*			Yes	No	Yes
4	175	2	6	6	2	*	*	*	*		Yes	No	No
5	60	8	6	6	4		*	*	*		Yes	No	Yes
6	220	6	3	3	3			*	*		Yes	No	Yes
7	35	6	12	12	4			*			Yes	No	Yes
8	100	12	5	5	5			*	*	*	Yes	No	Yes
9	80	6	4	3	3		*	*			Yes	No	No
10	150	4	8	6	5		*	*			Yes	Yes	Yes
Mean	139	6.8	6.2	5.8	4.4								

*Group I benzimidazoles and pro-benzimidazoles; group II tetrahydropyrimidines; group III avermectins and milbemycin; group IV other (*e.g.* praziquantel); group V halogenated salicylanilides and nitrophenols (unregistered horse products).

envelope with the return address accompanied each questionnaire. The breeders were requested to complete the questionnaire with close reference to their records and returned upon completion. Six months into the allowed response time only a small number of questionnaires were returned using the accompanying pre-paid envelope. In an attempt to increase the number of respondents, a study representative was given the task of visiting as many farms as possible to assist with the completion of the questionnaire. The questionnaires were completed in the presence of the representative and returned by the representative. The questionnaire included 44 questions of which 6 were open-ended (year of establishment, herd size, number of broodmares, total size of farm, total size of pastures and type of anthelmintics used since 1997), and the rest close-ended. Questions pertaining to treatment frequency were divided into the following categories: foals/weanlings (horses younger than 12 months), yearlings/youngsters (horses between the ages of 13 and 36 months) and adults (horses older than 3 years).

Some respondents failed to answer all the questions, with the result that the numbers of answers varied per category in the questionnaire. Unclear answers were followed up telephonically.

Anthelmintic resistance tests

A total of 283 horses on 10 of the larger Thoroughbred stud farms (> 20 horses/farm) within 250 km, by road, of Stellenbosch, Western Cape Province, were included in the tests to gauge the anthelmintic susceptibility of the different worm populations. The tests spanned a period of 9 months during 2001. Farms were selected on the willingness of the farmers to participate and on a minimum of 15 horses available for testing. None of the horses in the tests had been treated with anthelmintics for 2–3 months beforehand.

At the first visit to each farm, faecal samples were collected from as many horses as practically possible. On farms 2, 3, 4 and 10, only adult mares were sampled, because the owners were hesitant to allow collection of faecal samples rectally from younger animals. On farms 1, 5 and 6, only yearlings were included. However, on farms 7, 8 and 9 weanlings and yearlings were sampled and randomly divided into groups based on faecal egg count (FEC) and age. The use of weanlings and yearlings was mainly due to: 1) low egg counts (<100 epg) in the mares at the time, which resulted in a 2nd round of faecal collection and examination prior to treatment, and 2) the fact that the younger animals were stabled at night, on the relevant farms, facilitated the collection of faecal material from them. Nematode egg counts were performed on these samples using a modified McMaster technique[24] with a minimum detection level of 100 eggs per gram (epg) of faeces. All horses with an epg ≥150 were selected for the trial. The selected animals were randomly divided into groups comprising 2 (control and 1 anthelmintic), 3 (control and 2 anthelmintics) or 4 groups (control and 3 anthelmintics) according to FEC. The sizes of the various groups varied from 5–10 animals each. Within 3 days of the FECs having been done, each horse belonging to a treated group was dewormed with a paste formulation of 1 of the following: oxibendazole (Seroh, Virbac), ivermectin (Eqvalan, Merial) and moxidectin (Equest gel, Fort Dodge and Bayer). The weight of each animal was estimated with an Equi-feeds weigh band (95 % accuracy, van Niekerk, unpubl. data) and the dosage calculated as per manufacturer's instructions. Faecal samples were collected from all the horses in every test, 10 to 14 days after the day on which the tested animals were dewormed (post-treatment samples) and again analysed with the McMaster technique. All faecal samples were analysed blindly to prevent bias regarding the treatment allocation.

Faeces collected post-treatment was pooled per group that had positive nematode egg counts, before being cultured for 10 days at 27 °C ± 2 °C. The larvae that were harvested from the cultures were identified to genus level using the description of Bürger and Stoye[2].

The horses on the 10 experimental farms were kept on grass and received supplementary concentrates. The anthelmintic treatment practices and grazing management used on the 10 farms are summarised in Table 1.

Data analysis

Anthelmintic efficacy on each farm was estimated using the arithmetic means of the pre- and post treatment FECs of each treated group[3,4] in the following formulae:

Mean reduction:
$R = 100(1–X_t/X_c)$

Lower 95 % confidence limit (LCL):
$100[1–X_t/X_c \exp(+2.048 \sqrt{Y^2}\,]$

where X is the arithmetic mean for the treated (t) and control (c) groups. Y is the variance of reduction (log scale).

Resistance was confirmed if the FECR was less than 95 % and a lower 95 % confidence limit (LCL) less than 90 %. If only 1

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Table 2: **Mean herd size and average size of pastures where horses are kept by the Thoroughbred stud breeders who returned the questionnaires.**

Province	No. of farms	Mean no. of horses (range)	Average pasture size (range) (ha)
Western Cape Province	28	97 (15–250)	66.5 (0.5–250)
KwaZulu-Natal	16	120 (20–410)	103.1 (2–455)
Eastern Cape Province	5	108 (20–300)	107.6 (2.5–200)
Northern Cape Province	4	68 (15–100)	1800.0 (400–4000)
North West Province	2	160 (120–200)	400.0 (200–600)
Orange Free State	1	35	600.0
Mpumalanga	1	110	190.0

Table 3: **Reported frequency of annual anthelmintic treatments within 3 age groups on 57 Thoroughbred stud farms.**

Treatments per annum	Foals/weanlings (<12 months)	Yearlings/youngsters (13–36 months)	Adults (>3 years)
1	0	0	1 (2)
2	0	1 (2)	7 (13)
3	5 (9)*	6 (11)	3 (6)
4	5 (9)	4 (7)	8 (15)
5	6 (11)	6 (11)	9 (17)
6	13 (24)	20 (37)	18 (33)
7	3 (6)	1 (2)	1 (2)
8	6 (11)	7 (13)	3 (6)
9	1 (2)	1 (2)	0
10	4 (7)	1 (2)	2 (4)
11	0	0	0
12	11 (20)	7 (13)	2 (4)
Mean no. of annual treatments (±SD)	7.34 ± 2.97	6.61 ± 2.69	5.27 ± 2.31

*Percentage within age group in brackets.

of the conditions was met, resistance was suspected but not confirmed[3,4].

RESULTS

Questionnaire

Fifty-seven of the 110 questionnaires (51 %) were completed, of which 75 % were completed in the presence of a study representative. The distribution of farms, numbers of horses and average sizes of the pastures where the horses are kept, are listed in Table 2.

Body weights of the horses were measured with a scale in 5 % of cases or were estimated visually in 45 %, by the weigh band in 43 %, or both visually and by weigh band in 7 % of the cases. Dosages were calculated from the mean group weight in 50 %, from individual weights in 46 %, or both mean group and individual weights in 4 % of cases. The foals/weanlings received the highest average number of anthelmintic treatments annually, followed in turn by the yearlings/youngsters and then the adult horses (Table 3). Rotation between products was the norm, with the average number of rotations at 3.4 times per year, although some of the products that were rotated were within the same anthelmintic class. Three unrelated anthelmintic products were used on average per annum per farm (range 1–5). Most farmers used ivermectin during the period 1997 to 2000 (Table 4). In 1997 and 1998 pyrantel was dosed second most common, but was largely replaced by doramectin since 1999 (Table 4). Benzimidazoles were used on a large proportion of farms (Table 4). Within this group fenbendazole (average of 70 %) and oxibendazole (average of 19 %) were mostly used, while albendazole and oxfenbendazole were both used on an average of 5 % of the farms during the period 1997–2000.

The most important factors influencing the choice of anthelmintics were experience of good effect (91 %) and ease of administration (73 %). Fifty per cent of the farms indicated that the price of the drug is important and only 13 % said that they would choose an anthelmintic because it

Table 4: **Use of different anthelmintics on Thoroughbred stud farms during the period 1997–2000.**

Anthelmintic	1997 (n = 24)	1998 (n = 32)	1999 (n = 42)	2000 (n = 52)
Benzimidazoles	10 (42)*	10 (33)	16 (40)	21 (42)
Dichlorvos	2 (8)	2 (7)	2 (5)	2 (4)
Doramectin	6 (25)	12 (40)	20 (50)	23 (46)
Pyrantel	13 (54)	17 (57)	18 (45)	19 (38)
Ivermectin	18 (75)	21 (70)	29 (73)	38 (76)
Moxidectin	1 (4)	9 (30)	13 (33)	15 (30)
Other	7 (29)	8 (27)	9 (23)	11 (22)

*Percentage of farmers that use the anthelmintic.in brackets.

Table 5: **The frequency of different managerial practices on stud farms.**

Management factor	No. of farms	Percentage
Pasture rotation is used (*n* = 54)*	49	91
Horses are moved to clean pastures (*n* = 50)	40	80
Alternate grazing is used with cattle (*n* = 54)	23	43
Alternate grazing is used with sheep (*n* = 50)	3	6
Horse dung is spread on pastures (*n* = 51)	18	35
Horse dung is removed from pastures (*n* = 54)	33	61
Anthelmintic treatment is performed at pasture rotation (*n* = 52)	17	33
New horses are treated at introduction (*n* = 56)	53	95
Visiting horses are treated on arrival (*n* = 55)	43	78
Problem with colic after treatment (*n* = 55)	8	15
Disease registration is performed (*n* = 55)	45	82

*In brackets: number of farmers who supplied information.

is specifically registered for horses. The most important reason for treating horses was to prevent diseases (88 %). Only 38 % indicated that they treated their animals to save feeding costs.

The different management practices that were used are reported in Table 5. Most (91 %) of the farms changed to a different drug when decreased drug efficacy was suspected, at which stage 4 % increased the dosage of the drug concerned. Faecal egg counts were performed on 81 % of the farms and on average 3.3 times per year. Most of these counts were performed for randomly selected individuals (67 %) and for individuals in poor physical condition within a group (36 %). Eleven per cent of the farmers had FECs done on the entire herd. The FECRT was performed on 43 % of the farms at an average of once per year. The reasons for performing the FECRT were to evaluate the treatment efficacy (81 %) and the owner's personal interest (67 %). Helminths were regarded as a problem on 19 (35 %) of the farms.

Anthelmintic resistance trial

Reduced efficacy was recorded for oxibendazole on every 1 of the 10 farms, with an FECR of 0–88 % and the LCL were lower than 90 % in all cases. In contrast, ivermectin resulted in a 100 % reduction in FECs on the 9 farms where it was tested, as did moxidectin on 4 of 5 farms (Table 6). The pre-treatment larval cultures of the farms ranged from 95 % cyathostomes and 5 % large strongyles to 100 % cyathostomes and the post treatment cultures yielded only cyathostomes.

DISCUSSION

Incorrect dosage administration is one of several factors that can facilitate the development of AR[16]. The dosage recommended for any product is based on the minimum required concentration of the specific drug that will effectively remove a high proportion of worms (for example >90 %)[22,31]. Estimating the weight of a horse visually and using a single average weight to determine the dosage given to an entire group of horses (for example yearlings) are both inappropriate and can lead to an underestimation and subsequent under-dosing. If a single dosage is used for deworming a relatively uniform group of animals, it should rather be based on the weight, obtained with the weigh band, of the heaviest animal in the group[3].

Of concern is that 20 % and 13 % of the farmers deworm their foals/weanlings and yearlings/youngsters once a month, respectively, while a direct relationship has been shown between the frequency of treatments and the rate of AR development [14,15,16,27]. Therefore an over-protective dosing strategy, while highly effective in the short term, will not be sustainable owing to the development of AR. In addition, the development of natural immunity in young animals can be compromised[13,14,20]. Ideally, each farm and age group should have a separate management programme that provides adequate control with the lowest number of treatments[27,31].

Even though ivermectin was commonly used from 1997 to 2000 (also in Denmark[18] and the USA[14,23]), no AR development was reported in horses in this study or previously in South Africa[5,28]. This is strongly supported by 100 % reduction of FECs on every farm where it was tested in the present study. Benzimidazoles, which have been on the market

Table 6: **Results of faecal egg count reduction tests on 10 Thoroughbred stud farms in the Western Cape Province.**

Horse				Oxibendazole			Ivermectin			Moxidectin		
Farm	n	Class[a]	Mean epg Control[b]	Mean epg Treated[b]	FECR %	LCL %[c]	Mean epg Treated[b]	FECR %	LCL %[c]	Mean epg Treated[b]	FECR %	LCL %[c]
1	36	Y	1067	680	36	0	0	100	100	0	100	100
2	33	A	395	75	81	65	0	100	100	0	100	100
3	30	A	1475	190	87	66	0	100	100	0	99	95
4	28	A	877	435	50	0	0	100	100	–	–	–
5	15	Y	1300	233	82	71	–	–	–	–	–	–
6	40	Y	1845	385	79	68	0	100	100	0	100	100
7	23	W, Y	843	931	0	0	0	100	100	–	–	–
8	17	A	317	425	0	0	0	100	100	–	–	–
9	30	W, Y	1471	488	67	24	0	100	100	0	100	100
10	28	W, Y	920	110	88	52	0	100	100	–	–	–
Mean			1051	395.2	57	34.6	0	100	100	0	99.8	99

– Drug not tested on farm.
[a]Adult/yearling/weanling.
[b]Post-treatment faecal samples collected on Days 10–14.
[c]Lower 95 % confidence limit.

for horses for more than 2 decades, were still in frequent use by approximately 40 % of farmers who responded to the questionnaire survey. Thus the low mean efficacy of only 57 % for oxibendazole in the FECRTs was to be expected, even though a number of previous workers found oxibendazole to be effective against BZ-resistant populations[6,15,30]. It is likely that this situation resulted from frequent use of oxibendazole over the past few years, and from side-resistance from the far longer use of the other BZs before oxibendazole had come on the market.

From 1998–2002 the preference in South Africa for pyrantel pamoate apparently decreased from 57 % to 38 %. In the single investigation done previously with this drug in South Africa, mean percentage reductions of 96 % and 94 % were recorded at 2 sites, thus indicating marginal resistance at 1 of the sites. By contrast, a survey performed in Denmark showed suspected pyrantel resistance (LCL <90 %) on 20 % of the 15 farms tested for pyrantel using a 95 % reduction value[4].

Despite the fact that doramectin is not registered for use in horses in South Africa the survey indicated that it was used increasingly over the previous 4 years, even to exceed that of the BZs, pyrantel and moxidectin in 2000. The fact that doramectin is easy to administer intramuscularly with limited waste and cheaper than the other macrocyclic lactones on the market makes it more appealing to use. However, further studies should be performed to determine doramectin's re-treatment interval for horses. Information on the re-treatment intervals of different drugs is essential in order to caution farmers against re-treatment within or soon after this period. A concern is that the extensive use of doramectin might have significant implications on the rate of AR development against the avermectins. The widespread use of doramectin confirms that most horse owners in South Africa do not regard registered horse products as their only source of anthelmintics, but rather purchase products that appear to be effective in keeping their animals healthy, are easy to administer and cheaper.

Most farmers rotate their horses between paddocks previously grazed by horses and/or ruminants. Strongyle larvae and ascarid eggs are capable of surviving on pastures for extended periods under ideal environmental conditions[16,19,21]. It is also for this reason that the spreading of faecal material across a pasture is not an advisable management practice. Instead, where practical, efforts should rather be directed at the physical removal of faeces from the pastures once a week[27]. Some farmers have been using the so-called 'dose and move' practice for many years. The rationale behind this practice is the reduced re-infection rate that the horses will be exposed to when they are moved to clean pastures following anthelmintic treatment. However, the absence of susceptible worm populations on pasture (also known as worms in refugia) can facilitate a build-up of large numbers of resistant worms on the pasture[29].

While, according to the survey, the majority of farmers have FECs done approximately 3 times a year, in most cases this includes only a portion of the horses in each herd. It is important to realise that usually only a small number of horses require deworming in a group of adult horses, with the result that by sampling all the adult horses for FECs, it will be possible to treat only those animals that require it[7]. Using threshold FEC values for selecting horses that require deworming will not only contribute to the number of worms in refugia but will also reduce both costs and especially selection for AR. Only 1 study in South Africa have tested selective deworming and applied treatment at FECs ≥300[17]. However, selecting the appropriate threshold value for a herd will be influenced by factors such as the age group (weanling, yearling or adult) and by the management practices followed on the farm (*e.g.* grazing intensity).

Fewer than half of the farmers evaluate the effectivity of the anthelmintics that they use at a frequency of once a year. It is recommended that the FECRTs should be performed once a year to ensure that the farmers remain aware of the status of AR on the farm. Caution should be taken with all new and visiting animals as they both can potentially introduce resistant worm populations. It is evident from the survey that the majority of farmers treat both new and visiting horses on arrival. It is suggested though that the product used for this treatment should preferably be a non-BZ or a combination of 2 effective but unrelated drugs[16,27].

Based on the results obtained from this study there is a need for education regarding the correct use of anthelmintics on South African Thoroughbred stud farms. Most farmers are unaware of the status of anthelmintic resistance on their farms and little attention is given to alternative management interventions that can potentially delay its development or prevent the acquisition of resistant worm populations. It is expected that the problem will become much greater unless a concerted effort is made to educate farmers about effective integrated management systems for the control of helminths.

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