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The effect of dose level of steroid immunogen on the reproductive performance of ewes

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ABSTRACT

A major constraint on the profitability of using 'Fecundin®' is the cost of treatment and one approach to this problem is to reduce the dose rate. In 1984 Coopworth ewes were allocated to 3 groups. One group was untreated (control) while the other 2 groups were injected twice with Fecundin. One treated group received a full dose (2ml) each time while the other group received a half dose (1ml) on both occasions. In 1985 the same ewes were reboosted with Fecundin®. Control ewes remained untreated while ewes from each dose group in 1984 were boosted with either a half or full dose.

In the first year, both immunised groups showed a substantial increase in ovulation rate over controls (2.45 full, 2.20 half and 1.86 control). The higher ovulation rate of full dose compared to half dose ewes did not result in more lambs born or weaned (lambs born/ewes joined were 1.68 full, 1.65 half and 1.35 control). In 1985 all 4 treatment groups had a higher ovulation rate (2.43) than the control (2.03) and there were no difference between immunisation treatments. A similar pattern was seen in lambs born.

Thus the cost of treatment can be halved by using a 1 ml dose of Fecundin® without a drop in the additional performance obtained.

Keywords Steroid immunisation; Fecundin®; Coopworth; dose rate; reproduction; ewes; lambing; ovulation rate

INTRODUCTION

The use of a steroid antigen (Fecundin®, Glaxo NZ Ltd) to increase lambing performance in ewes results in an average increase on 23.2 lambs born/100 ewes joined. However increases have ranged from -2 to +55 lambs/100 ewes in individual flocks (Smith, 1985a). This variability in response is a major factor influencing the profitability of treatment and the likehood of breaking even (Scobie and Bircham, 1985; Smith *et al.*, 1985b). Another significant factor that contributes to the marginal economics of the technology is the cost of treatment. A reduction in the cost of treatment would not only markedly improve the economics of the technique (G.M. Scobie and J.S. Bircham personal communication) but also increase the likehood of breaking even by reducing the level of response needed to achieve this (Smith, 1984).

The variation in response is primarily due to differences in the levels of conception and embryonic mortality upon neither of which can much control be achieved. However the cost of treatment could be cut by reducing the dose level. This paper reports on a trial conducted to compare the efficiency of a half and a full volume dose rate of Fecundin® on increasing the reproductive performance of Coopworth ewes.

MATERIALS AND METHODS

In January 1984, 246 2-tooth Coopworth ewes were allocated on the basis of live weight to 3 groups. Two groups were injected with Fecundin® on 22 February and again on 22 March. One group received a full dose (2ml) both times while the second group received a half dose (1ml) on both occasions. The third group were untreated and acted as controls. All ewes were mated in one mob with 10 Southdown rams for 6 weeks commencing 12 April. Laparoscopy to determine ovulation rate was performed on 1 May when a blood sample was taken for antibody titre determination. Ewes were divided into treatment groups and detailed lambing records obtained and lamb survival from birth to weaning recorded.

In 1985 the same ewes were used. The control group remained untreated. Ewes from each dose group in 1984 were divided into 2 groups and boosted with either a half (1ml) or full (2ml) dose of Fecundin® on 7 March. All ewes were synchronised with CIDRs and on 8 April were joined with entire Coopworth rams at the second oestrus after CIDR removal. Ovulation rate was determined by laparoscopy on 15 April. Rams were removed after 6 weeks of mating. The ewes were ultrasonically scanned for pregnancy diagnosis on 20 June. Detailed lambing records were obtained and survival and growth to weaning recorded.

Antibody titre levels were determined from blood samples taken 30 d after the booster injection in 1984 and 14 and 42 d after booster in 1985. In both years the Fecundin® was used within 6 months of manufacture and it contained 0.6mg polyandroalbumin/ml.

RESULTS

1984 Reproductive Performance

Ovulation

There was no treatment effect on the proportion of ewes ovulating (Table 1). Immunisation at either dose increased ovulation rate (OR) above that of the controls ($P<0.001$) and there was an effect ($P<0.01$) of dose with the higher OR following the higher dose of antigen (Table 1).

Lambing

There was no effect of treatment on the proportion of ewes joined that lambed overall (Table 1). However there was a delay ($P<0.05$) in conception in the immunised groups as shown by the pattern of lambing (Table 2).

Immunisation increased ($P<0.001$) the number of lambs born/ewe lambing above the controls but there was no significant difference between dose levels of antigen. This was reflected in the numbers of lambs born/ewe joined and is illustrated in the lambing distribution shown in Table 2.

Embryonic loss

The level of embryonic loss was examined on the basis of the ovulation rate and lambs born in the first cycle. Total loss (total ovulations-lambs born) was partitioned (Table 1) into that due to:

(i) full loss (conception failure and/or complete wastage) and

(ii) partial loss or partial failure of multiple ovulation (PFMO = difference between the ovulation rate of, and lambs born to, the ewes lambing in the first cycle). Total embryonic loss was higher in immunised ewes than in controls ($P<0.01$), and within immunisation treatments was higher with full dose than half dose ($P<0.05$). There were no significant differences between treatments in the levels of PFMO but nor were there any significant differences in the ratio of partial to full embryonic loss. Thus similar but non-significant trends were seen in the treatment difference of partial embryonic loss as were seen in the full loss.

TABLE 1 Effect of dose of immunogen on reproductive performance in 1984.

	Dose of immunogen		
	2 x 2ml	2 x 1ml	Control
No. ewes joined (EJ)	82	82	77[a]
At first cycle—			
No. ewes ovulating	77	81	77
No. ovulations (OVT)	189	178	143
Ovulation rate (OR)	2.45	2.20	1.86
No. ewes lambing (EL1)	45	53	60
No. ovulations of EL1 (OVL1)	116	121	114
No. lambs born (LB1)	85	100	95
Embryonic loss (% of OVT)			
Full (OVT-OVL1)	38.6	32.0	23.1
Partial (OVL1-LB1)	16.4	11.8	12.3
Total (OVT-LB1)	55.0	43.8	35.4
Overall			
No. ewes lambing (EL)	73	77	71
Dry ewes/EJ (%)	11.0	6.1	7.8[b]
Lambs born/EL	1.89	1.75	1.46
Lambs born/EJ	1.68	1.65	1.35
Lambs weaned/lambs born (%)	89.9	91.1	88.5
Lambs weaned/EJ	1.51	1.50	1.19

[a] 5 ewes died between date of treatment and lambing (deleted from records).
[b] includes one ewe that aborted.

1984 Lamb Performance

The data on lamb survival and birth weights in 1984 are summarised in Table 3. Overall lamb mortality was low (9.7%) and there were no significant differences due to treatment. Birth rank did not influence mortality while birth weight decreased with increasing birth rank ($P<0.05$). There was no treatment by birth rank interaction on lamb birth weight.

TABLE 2 Effect of dose of immunogen on distribution (% of ewes joined) and pattern (% of ewes lambing) of lambing in 1984.

	Dose of immunogen		
	2 x 2ml	2 x 1ml	Control
With 0 lambs	11.0	6.0	8.0
1 lamb	22.0	33.0	53.0
2 lambs	55.0	51.0	35.0
3 lambs	12.0	10.0	4.0
Lambing in week			
1	37.0	44.1	57.8
2	26.0	24.7	22.5
3	24.7	16.9	7.0
4	5.5	7.8	7.0
5-8	6.8	6.5	5.6

TABLE 3 Effect of dose of immunogen and birth rank of lamb mortality to weaning and on birth weight and weaning weight in 1984.

	Dose of immunogen		
	2 x 2ml	2 x 1ml	Control
Singles			
No. born	18	27	41
Mortality (%)	5.6	3.7	14.6
Twins			
No. born	90	84	54
Mortality (%)	11.1	9.5	8.0
Triplets			
No. born	30	24	9
Mortality (%)	10.0	12.5	22.2
Lamb birth weight (kg)			
Single	5.21	5.33	5.13
Twin	4.29	3.96	3.94
Triplet	2.94	3.46	3.19
Lamb weaning weight (kg)			
Single	24.8	22.3	23.9
Twin	18.2	19.9	21.2
Triplet	15.4	17.9	17.4

TABLE 4 Effect of dose of immunogen on reproductive performance in 1985.

	Dose of immunogen				
1984	2 x 2ml	2 x 2ml	2 x 1ml	2 x 1ml	Control
1985	1 x 2ml	1 x 1ml	1 x 2ml	1 x 1ml	
No. ewes joined (EJ)	38	38	39	40	68
At first cycle—					
No. ewes ovulating	36	38	38	39	67
No. ovulations (OVT)	83	96	93	96	136
Ovulation rate (OR)	2.31	2.53	2.45	2.46	2.03
No. ewes lambing (EL1)	26	18	23	24	47
No. ovulations of EL1 (OVL1)	60	41	54	54	97
No. lambs born (LB1)	50	32	40	43	74
Embryonic loss (% of OVT)					
Full (OVT-OVL1)	27.7	57.3	41.9	43.8	28.7
Partial (OVL1-LB1)	12.1	9.4	15.1	11.4	16.9
Total (OVT-LB1)	39.8	66.7	57.0	55.2	45.6
Overall					
No. ewes lambing (EL)	35	34	36	36	59
Dry ewes/EJ (%)	7.9	10.5	7.7[a]	10.0	13.2
Lambs born/EL	1.89	1.68	1.75	1.83	1.61
Lambs born/EJ	1.74	1.50	1.62	1.65	1.40
Lambs weaned/lambs born (%)	81.8	87.7	87.3	89.4	85.3
Lambs weaned/EJ	1.42	1.32	1.41	1.48	1.19

[a] Includes 2 ewes aborting

1985 Reproductive Performance

Ovulation

Treatment did not affect the proportion of ewes ovulating. The treated ewes had a higher ($P<0.001$) ovulation rate than the control ewes but there were no significant effects of level of treatment in either year on ovulation rate (Table 4).

Lambing

Treatment did not affect the proportion of ewes lambing (Table 4) but did affect ($P<0.01$) the distribution of ewes having singles, twins or triplets (Table 5). There were more lambs born/ewe lambing in the treated groups. The level of treatment dose in the first year affected the distribution ($P<0.05$). Ewes treated with the full dose in the first year had a higher proportion of triplets while those treated with a half dose had a higher proportion of twins. The level of the booster dose in the second year had no effect and there was no significant interaction of dose and year. There was an effect of treatment ($P<0.01$) on the pattern of lambing with less treated ewes lambing in the first week (Table 5).

Embryonic loss

There were significant effects of treatment (Table 4) on total embryonic loss ($P<0.05$) and on full loss ($P<0.01$). While there were no significant treatment effects on partial loss there was an effect of treatment

TABLE 5 Effect of dose of immunogen on distribution (% of ewes joined) and pattern (% of ewes lambing) of lambing in 1985.

	Dose of immunogen				
1984	2 x 2ml	2 x 2ml	2 x 1ml	2 x 1ml	Control
1985	1 x 2ml	1 x 1ml	1 x 2ml	1 x 1ml	
With 0 lambs	7.9	10.5	7.7	10.0	13.2
1 lamb	31.6	39.5	28.2	22.5	35.3
2 lambs	39.5	42.1	59.0	60.0	50.0
3, 3+ lambs	21.1	7.9	5.1	7.5	1.5
Lambing in week					
1	11.4	8.8	13.9	5.4	27.6
2	60.0	38.2	47.2	56.8	51.7
3	8.6	20.6	13.9	10.8	10.3
4	11.4	26.5	19.4	13.5	8.6
5-8	8.6	5.9	5.6	13.5	1.7

($P<0.05$) on ratio of full to partial loss, with partial loss contributing less to the total loss in treated ewes (21.2% v 37.1%).

Level of treatment in the first year had no effect on embryonic loss but dose in the second year affected full loss ($P<0.01$) and total loss ($P<0.05$) and interacted ($P<0.01$) with first year dose on both full and total loss (table 4). Ewes treated with the half dose in the second year and in particular those that had had a full dose the previous year had higher levels of full and total loss.

1985 Lamb Performance

Treatment did not affect mortality but birth rank did ($P<0.001$) with higher mortality in the triplets and quads (Table 6). However there was an interaction ($P<0.05$) between treatment and birth rank on mortality with highest mortality for lambs of treated ewes in the triplets while for lambs of the controls it was highest in the singles. Birth rank affected ($P<0.01$) birth weight but there was no treatment by birth rank interaction.

Titre Levels

The steroid antibody titre levels (Table 7) indicate an effect of dose of antigen ($P<0.001$) on titre levels in 1984 with the full dose giving higher titres than the half dose and also a wider range of titres. However in 1985 there were no significant effect of the dose of antigen used in either year nor any interaction between primary and booster doses.

TABLE 6 Effect of dose of immunogen and birth rank lamb mortality to weaning and on birth weight and weaning weight in 1985.

		Dose of immunogen				
	1984	2 x 2ml	2 x 2ml	2 x 1ml	2 x 1ml	Control
	1985	1 x 2ml	1 x 1ml	1 x 2ml	1 x 1ml	
Singles						
No. born		12	15	11	9	24
Mortality (%)		0	6.7	0	11.1	16.7
Twins						
No. born		30	32	46	48	68
Mortality (%)		6.7	6.3	15.2	2.1	14.7
Triplets						
No. born		24	10[a]	6	9	3
Mortality (%)		41.7	40.0	16.7	55.6	0
Lamb birth weight (kg)						
Single		5.56	5.70	5.47	6.10	5.61
Twin		4.40	4.28	4.12	4.40	4.30
Triplet		3.44	3.17[a]	3.98	3.68	.
Lamb weaning weight (kg)						
Single		22.2	22.8	23.4	23.2	
Twin		19.5	19.1	18.7	19.6	20.0
Triplet		18.8	14.9	18.7	19.0	14.0

[a] Includes 1 set of quads.

TABLE 7 Effect of dose of antigen on androstenedione antibody titre in both years.

	Dose of immunogen			
1984	2 x 2ml		2 x 1ml	
1984 titre				
Mean $\log_e \pm$ s.e.m.	5.312±0.153		4.646±0.132	
Range	(7-10000)		(5-1194)	
Geometric mean	203		105	
Dose of antigen 1985	1 x 2ml	1 x 1ml	1 x 2ml	1 x 1ml
1985 titre				
Mean $\log_e \pm$ s.e.m.	5.042±0.182	4.749±0.168	5.00±0.151	4.883±0.131
Range	(13-912)	(14-1167)	(11-1239)	(19-393)
Geometric mean	155	114	148	132

DISCUSSION

These results clearly indicate that the use of a 1 ml dose of Fecundin® was as effective as a normal 2 ml dose in increasing lambing performance of ewes both for the 2 primary injections in the first year of treatment, and for a booster injection in subsequent years. These results are supported by field trial data (C. Kelly, personal communication) and from unpublished trial data (T.W. Knight, personal communication). The present data are the first to be presented for animals that were both primed and boosted over 2 years with half the normal dose.

The similarity of reproductive response at the 2 dose rates is a reflection of the antibody titre levels produced with the 2 treatments. Those indicate a significant increase of titre with dose of antigen in the first year but no effect of dose in either year on the titre level measured at the time of mating in the second year. The difference in titre in 1984 is reflected in a higher ovulation rate of the ewes receiving the full dose rate in that year. This agrees with the previously established relationship between titre level and ovulation rate (Smith *et al.*, 1983, 1985a).

The lack of difference between groups in titres in 1985 was reflected in the similarity of ovulation rates. The similarity of antibody titres following different doses of antigen in the second year probably reflects a similar population of antigen memory cells available to be stimulated in both groups of ewes, and that 1 ml of antigen was adequate for this stimulation. The antibody and ovulatory response obtained following a booster injection is more dependent on the activity of the antigen+adjuvant combination used for the priming injection than on the strength of the booster material (J.F. Smith, unpublished). The age of the Fecundin® used in the present experiment is unlikely to have markedly influenced the response as similar antibody titre levels have been obtained when fresh material and material 6 months beyond its 12-month expiry date has been administred (J.F. Smith and T.W. Knight, unpublished).

The effect of a reduction in dose of antigen would be to reduce the cost/treatment from $1.50 to 75c. This reduction in cost could have marked implications on the economics of the use of Fecundin®. It would reduce the level of increase in lambing required to break even to about 10% (Smith, 1984) and thus reduce the probability of incurring a loss to less than 15%. It would increase the net return to an average response. This would also increase the flexibility of management and even make viable the proposition to reduce the number of ewes carried over winter (G.M. Scobie and J.S. Bircham personal communication). The present findings on the effect of a reduced dose level should therefore markedly increase the opportunities for the profitable use of Fecundin®.

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