RESPONSE TO SELECTION FOR LITTER SIZE BASED ON BLUP IN GOLDEN HAMSTERS

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SUMMARY

Significant responses were obtained to five generations of selection for litter size at birth and litter weight at weaning in golden hamsters. The selection was based on the best linear unbiased prediction (BLUP) of breeding values under multiple trait animal model. The base population was established with progenies of a 4-way cross sires and dams between 4 inbred lines. The heritability estimate of litter size in the base population was 0.07. The population was subdevided into three lines as 1. selection line for litter size at birth, litter weight at weaning and 8-week body weight (line W), 2. selection line for litter size and litter weight (line R) and 3. control line (line C). The animals in the lines W and R were selected on the basis of high aggregate genotype with multiple trait BLUP and the line C was maintained as randomly breeding control. The breeding population size of the lines W and R was 35 sires and 70 dams, and of the line C was 35 sires and 35 dams for each generation.

The mean litter sizes at generation 5 were 12.4, 11.9 and 10.7 for the lines W, R and C, respectively. The deviations of W and R from C: 1.7 and 1.2 pups, were statistically significant ($P<0.01$ and 0.05). The mean litter weights at weaning in generation 5 were 205 g, 201 g and 170 g for the lines W, R and C, respectively. The deviations of the selection lines from the control line were significant ($P<0.01$). The additional use of 8-week body weight to litter size and litter weight as a selection criterion brought us a larger responses in these two traits.

INTRODUCTION

Genetic improvement in reproductive performance of livestock have an economic importance in the whole productivity. However the genetic improvement of litter size at birth in pigs by selection is considered to be difficult because of its low heritability and low selection intensity due to sex-limited nature of the trait (Rutledge 1980; Vangen 1981; Ollivier 1982). There are successful experiments of mass selection for litter size in mice (Bradford 1971; Eklund et al. 1977; Bakker et al. 1978; Eisen 1978; Joakimsen et al. 1978), but these experiments took relatively long time and many generations to obtain significant genetic gains. Avalos et al. (1987) indicated that the use of family selection indices has been a promising method for increasing litter size in pigs.

The objective of this experiment is to examine the short-term effects of selection for reproductive traits based on the best linear unbiased prediction of breeding values under multiple trait animal model (Henderson 1976) in hamsters.

MATERIAL AND METHODS

The base population was established with progenies of a 4-way cross sires and dams between 4 inbred lines of hamsters. The population parameters were estimated using the data of 4-way cross and base population as shown in Table 1. The base population was subdevided into three lines as 1. selection line for litter size at birth, litter weight at weaning and 8-week body weight (line W), 2. selection line for litter size and litter weight (line R) and 3. control line (line C). The breeding population size of the lines W and R was about 35 sires and 70 dams, and of the line C was about 35 sires and 35 dams for each generation. One male and two females were caged together for random-mating in selected animals avoiding close inbreeding for 12 days.

The litter size defined as the number of pups born alive was counted within 12 h after birth. Then the litter size was standardized to eight (4 males and 4 females) as close as possible within each litter without fosterage at a day after birth. The all young were weaned and males and females were separated at 3 weeks of age. They were reared as a group of 6 or 7 animals in a cage up to 10 weeks of age. The individual body weight was recorded at 8 weeks of age.

The animals in the lines W and R were selected on the basis of high aggregate genotype with multiple trait BLUP and the line C was maintained as randomly breeding control. The economic weights of litter size, litter weight and 8-week body weight were assigned as 1.690, 0.026 and 0.199, respectively, using the genetic standard deviations of these traits. The maximum number of individual selected from one litter was limited to 2 males and 4 females in the selection lines and 2 males and 2 females in the control line.

Hamsters had free access to pellet feed and water in the rooms kept at a temperature 23.0±1.0 °C and a humidity about 50 %. The light period in a day was 14 h from 6:00 to 20:00 throughout the experiment.

Table 1. Estimates of population parameters

		(1)	(2)	(3)
Litter size at birth	(1)	0.07	0.15	0.26
Litter weight at weaning (g)	(2)	0.36	0.34	0.04
8-week body weight (g)	(3)	0.39	-0.26	0.42

diagonal: heritability, upper diagonal: phenotypic correlation, lower diagonal: genetic correlation

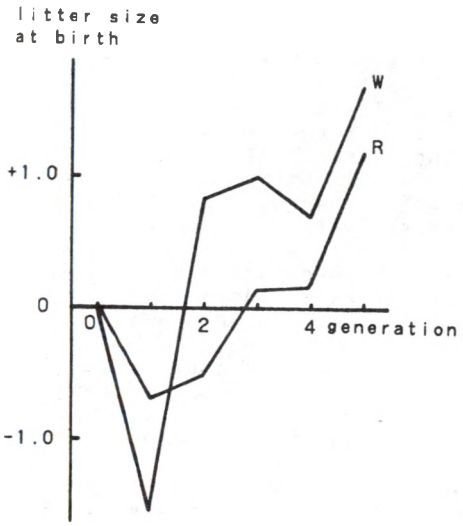

Fig. 1. Selection responses in litter size at birth as deviations from control.

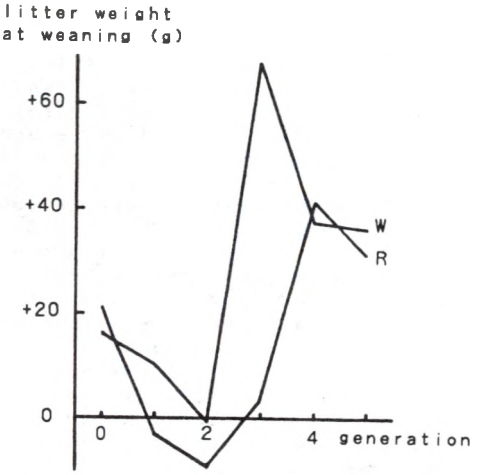

Fig. 2. Selection responses in litter weight at weaning as deviations from control.

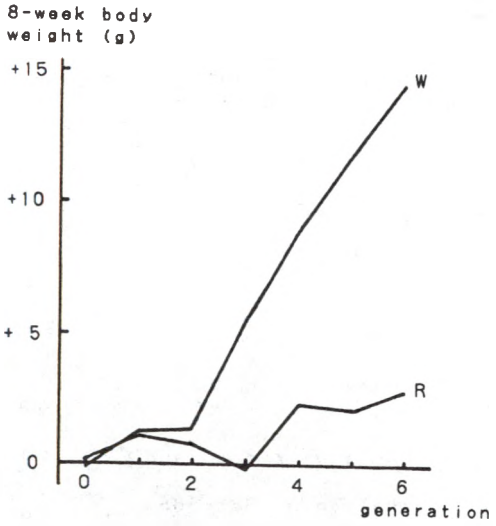

Fig. 3. Selection responses in 8-week body weight as deviations from control.

RESULTS AND DISCUSSION

The selection responses in litter size, litter weight and 8-week body weight were presented in Figs 1, 2 and 3 as the deviations from the means of control line. The mean litter sizes at generation 5 were 12.4, 11.9 and 10.7 for the lines W, R and C, respectively. The deviations of W and R from C; 1.7 and 1.2 pups, were statistically significant at $P<0.01$ and $P<0.05$. The mean litter weights at weaning in generation 5 were 205 g, 201 g and 170 g for the lines W, R and C, respectively. The deviations of the selection lines from the control line were highly significant ($P<0.01$). The mean 8-week body weights at generation 6 were 99.8 g, 88.2 g and 85.4 g for the lines W, R and C, respectively. The mean of the line W was larger than that of C by 14.4 g and this difference will be augmented in future.

The additional use of 8-week body weight to litter size and litter weight as a selection criterion brought us a larger responses in these two traits in W and R. These may be the results of possitive correlated responses caused by the selection for 8-week body weight. The mean inbreeding coefficients were 3.9, 4.5 and 2.5 % for the lines W, R and C at generation 6, respectively. The between line differences in mean inbreeding coefficients are still small at generation 6. However, since the full-sib family selection base only on the litter records in the line R will accelerates the rate of inbreeding more than the mixed family and individual selection based on the litter records and the individual body weight in the line W, the line differences of the mean inbreeding coefficient will be increased in subsequent generations. Consequently inbreeding depressions in reproductive traits are expected to be smaller in the line W than in the line R.

The use of information from many relatives of candidates in a closed population breeding by BLUP method increased the accuracy of selection and enabled us to obtain the significant responses in reproductive performance within relatively short-term selection experiment.

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