The Growth Performance of Two Lines of Pig Reared under Two Differing Environmental Conditions

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Introduction

There have been numerous studies reporting the differences in performance levels and carcass characteristics between contrasting breeds and lines of pigs. Additionally, there is also a body of literature reporting that increased group size and reduced floor space allowance (crowding) results in reduced feed intakes and growth rates (Edmonds et al., 1998; Hyun et al., 1998). It is well known that the animal's environment dictates the level to which it will express its genetic potential. Thus, the concept of genotype x environmental interactions (G x E) becomes important. Merks (1986), defined a G x E as a change in the relative performance of two or more genotypes measured in two or more environments. Several researchers have shown that genotype x environmental interactions may exist in swine populations (Bidanel and Ducos, 1996; Merks, 1989). As commercial producers continue to try new techniques to increase the efficient use of their facilities such as large group sizes and increased stocking densities, the presence of genotype x environmental interactions may become more important. The objective of this study was to investigate the interaction between genetic growth potential and rearing environment.

Materials and Methods

Experimental Design and Treatments. This study compared three treatments with three replicates over time. The treatments were: sire line (line A vs line B, [Pig Improvement Company, U.S.A., Franklin, KY]), environment (spacious vs crowded), and sex (barrows vs gilts). The protocol for this study was approved by the University of Illinois Laboratory Animal Care Committee.

Animals and Management A total of 736 pigs were put on test at a average of approximately 40 kg live weight. Line A was Pietrain-based and line B was a synthetic containing Large White, Landrace, Duroc and Pietrain. These two lines were chosen on the basis of previous data to represent the range in growth rate among sire lines from this genetic source (Miller et al., 2000). Sires from line A (n = 8) and line B (n = 9) were mated to PIC Camborough 22 dams. All lines used in this study had been tested as free of the detrimental alleles of both the Halothane and RN genes. Pigs were housed in like-genotype, like-sex groups and were allocated to test group on the basis of sire and weight.

The study was conducted in a mechanically ventilated building at the University of Illinois Swine Research Center which had part-solid, part-slotted floors. The spacious environment consisted of small groups (4 pigs) with a more than adequate floor space allowance (0.93 m^2/pig for the entire grow-finish period). Pigs in the crowded environment were in larger groups (12 pigs) with a reduced floor space allowance [(0.37 and 0.56 m^2/pig for the grower (40 to 80 kg) and finisher (80 to 120 kg) phases, respectively)]. At a mean pen weight of 80 kg, the crowded environment pens were enlarged by widening the existing pen, keeping a constant ratio of solid to slotted floor. Pigs were given ad libitum access to feed from a two-hole feeder and were fed on a three-phase dietary program; diets were based on corn and soybean meal (Table 1).

Measurements. Pigs were individually weighed every 14 d in the first and third replicate and every 21 d in the second replicate. In addition, animals were weighed weekly when they approached 80 kg, for pen size adjustment for the crowded environment, and 120 kg, the end of test weight. The coefficient of variation for each pen was calculated at the start and the end of the test. Feed additions were recorded and feeder weights were taken at each weighing. Ultrasound scanning was performed on every pig at each weigh date. Fat-free lean percentage was calculated at 120 kg live-weight using an equation presented by Cisneros et al. (1996).

Results and Discussion

Effect of Sire line. There were no significant ($P > 0.05$) interactions between genotype and environment fro any of the traits. No difference ($P > 0.05$) in the coefficient of variation of end weights was found between line A and line B pigs (Table 2). Line A animals grew significantly slower ($P < 0.05$) during both phase 2 (80 to 120 kg) and the overall test period, and required more days to reach slaughter weight compared to line B pigs (Table 3). Line B pigs had higher daily feed intake ($P < 0.05$) than line A for phase 2 but not for phase 1 or the overall period, however, gain:feed was lower for line A pigs for phase 1 and for the entire test period (Table 3). Line A was a Pietrain-based line and studies conducted with lines based on this breed have generally shown slower growth and poorer feed efficiency for this genotype (Howard and Smith, 1977). In addition, line A pigs had greater loin depths ($P < 0.05$), and similar fat depth and fat-free lean percentage when compared to line B pigs (Table 3).

Effect of Environment. Environment did not have any effect on the coefficient of variation of live weight at the end of the study (Table 2). Pigs placed in the crowded environment had lower ($P < 0.05$) average daily gain and average daily feed intake during phases 1 and 2 and the entire test period compared to pigs reared in the spacious environment. Gain:feed was also lower ($P < 0.05$) for the crowded environment pigs during phase 1 and the overall test period, but did not differ for phase 2 (Table 3). Edmonds et al. (1998) reported similar results for animals placed in crowded pens. However, most studies have shown that a reduction in floor space allowance results in a reduction in average daily gain and average daily feed intake with no effect on gain:feed (NCR-89, 1993; McGlone and Newby, 1994; Brumm and Miller, 1996).

Effect of Sex. Gilts had less ($P < 0.05$) variation in live weight at the end of the study than barrows (Table 2). Barrows grew faster ($P < 0.05$) during phase 2 and the entire test period and consumed more feed ($P < 0.05$) and had poorer feed efficiency ($P < 0.05$) compared to gilts throughout the trial (Table 3). Gilts had less ($P<.05$) backfat and a greater loin eye depth and a higher fat-free lean percentage compared to barrows (Table 3). Other studies have reported higher average daily gain and average daily feed intake, lower gain:feed, greater backfat thickness with less loin eye area for barrows compared to gilts (Cisneros et al., 1996; Ellis et al., 1996).

Conclusions

1. The differences in growth rate and carcass characteristics between the sire lines used in this study emphasizes the importance of selecting a sire line that meets the goals of the specific swine operation.

2. The large reduction in growth rate for the pigs reared in the crowded environment highlights the impact that group size and floor space allowance has on growth performance.

3. This study reduces the concern of negative effects on carcass lean content for pigs that are reared in a crowded environment with a lower than recommended floor space allowance.

4. The absence of genotype x environmental interactions in the present study indicates that the two sire lines responded similarly to the two environments, however, more studies need to be conducted with more genetic lines and environments to confirm these results.

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Table 1. Diet formulations and percentage composition[a]

	Live weight range, kg		
Ingredient (%)	40-70	70-100	100-120
Corn	70.120	74.690	80.491
Soy bean meal (48%)	25.050	20.700	15.154
Soybean oil	1.500	1.500	1.500
L-Lysine-HCL	0.120	0.085	0.195
DL-Methionine	0.030	0.015	0.000
Dicalcium phoshphate	1.570	1.390	1.220
Ground Limestone	0.760	0.780	0.790
Trace mineral salt[b]	0.350	0.350	0.350
Vitamin mix[C]	0.200	0.200	0.200
Copper sulfate	0.100	0.100	0.100
Tylan (2%)	0.200	0.200	0.200
Calculated compostion			
Crude protein, %	18.200	16.500	14.300
Lysine, %	1.050	0.900	0.820
Calcium, %	0.750	0.700	0.615
Phosphorous, %	0.650	0.600	0.525
ME, kcal/kg	3384	3390	3386

[a] As-fed basis.
[b] Each kilogram of mix contained the following: Se, 85.7 mg; I, 100 mg; Cu, 2.3 g; Mn, 5.7 g; Fe, 25.7 g; Zn, 28.6g; NaCl, 855 g.
[c] Each kilogram of mix contained the following: vitamin A, 3,000,000 IU; vitamin $D_{3,}$ 330,000 IU; vitamin E, 44,000 IU; vitamin K, 2.2 g; vitamin B_{12}, 17.9 mg; riboflavin, 4.4 mg; d-pantothenic acid, 12.1 g; niacin, 16.5 g; choline chloride, 165 g; and roughage products to 1 kg.

Table 2. Least square means for genetic line, environment and sex for live weights, mortality and removal rate.

Variable	Genotype			Environment			Sex		
	Line A	Line B	Ave SE	Spacious	Crowded	Ave SE	Barrows	Gilts	Ave SE
Number of pens	45	47		46	46		47	45	
Start weight, kg	40.7	41.0	0.28	41.2	40.5	0.28	41.1	40.6	0.28
Switch weight, kg	80.1	80.0	0.63	80.0	80.1	0.63	80.2	79.9	0.63
End weight, kg	120.0	120.7	0.53	120.1	120.6	0.53	120.4	120.3	0.53
Start CV[a], %	7.6	7.5	0.39	7.3	7.8	0.39	8.0	7.1	0.39
End CV[a], %	7.7	7.0	0.50	6.8	7.9	0.50	8.2[c]	6.5[b]	0.50
No. animals at start	356	380		184	552		380	356	
No. animals died	4	6		1	9		4	6	
No. animals removed	7	12		3	16		14	6	
Percentage of animals dying or removed	3.1	4.7		2.2	4.5		4.7	3.3	

[a] CV = Coefficient of variation was determined using pen means.
[bc] Means in the same row with differing superscripts differ, $P \leq 05$.

Table 3. Least square means for genetic line, environment and sex for growth performance.

Variable	Genotype			Environment			Sex			G × E
	Line A	Line B	Ave	Spacious	Crowded	Ave SE	Barrows	Gilts	Ave SE	P value
Days on test	86.1[b]	82.0[a]	0.94	79.5[a]	88.6[b]	0.96	82.6[a]	85.4[b]	93.1	0.59
Average daily gain, g										
Phase 1 (40 - 80 kg)	918	940	10.6	990[b]	868[a]	10.7	942	915	10.6	0.69
Phase 2 (80 - 120 kg)	912[a]	991[b]	14.5	997[b]	906[a]	14.8	979[b]	923[a]	14.5	0.97
Overall (40 - 120 kg)	915[a]	965[b]	9.4	993[b]	887[a]	9.6	961[b]	919[a]	9.4	0.63
Average daily feed intake, g										
Phase 1 (40 - 80 kg)	2350	2320	24.1	2441[b]	2229[a]	24.6	2411[b]	2259[a]	24.1	0.78
Phase 2 (80 - 120 kg)	2905[a]	3082[b]	40.0	3167[b]	2820[a]	40.8	3156[b]	2831[a]	40.1	0.45
Overall (40 - 120 kg)	2627	2701	26.9	2804[b]	2524[a]	27.4	2784[b]	2545[a]	26.9	0.49
Gain : Feed										
Phase 1 (40 - 80 kg)	0.39[a]	0.41[b]	0.004	0.41[b]	0.39[a]	0.004	0.39[a]	0.41[b]	0.004	0.40
Phase 2 (80 - 120 kg)	0.31	0.32	0.003	0.32	0.32	0.003	0.31[a]	0.33[b]	0.003	0.11
Overall (40 - 120 kg)	0.35[a]	0.36[b]	0.003	0.36	0.35	0.003	0.35[a]	0.37[b]	0.003	0.08
Carcass measurements[c], mm										
Fat depth	14.7	14.3	0.29	14.4	14.6	0.29	15.7[b]	13.3[a]	0.29	0.14
Loin eye depth	60.4[b]	56.9[a]	0.38	58.1	59.1	0.38	58.0[a]	59.2[b]	0.38	0.47
Predicted fat-free lean percent[d]	57.1	57.0	0.12	57.0	57.1	0.12	56.6[a]	57.5[b]	0.12	0.07

[ab] Means in the same row with differing superscripts differ, P ≤ 05.

[c] Measured at 120 kg live weight using ultrasound.

[d] Predicted form fate depth and longisimuss measurements using the equation of Cisneros et al., 1996.