

Efficacy of Three Porcine Circovirus Vaccination Regimens on Growth Parameters and Circovirus Titers in Nursery and Growing/Finishing Pigs

B. E. Bass¹, J. W. Frank¹, Z. B. Johnson¹, C. V. Maxwell¹, and P. R. Dubois²

Story in Brief

An experiment was conducted to evaluate the effectiveness of different porcine circovirus (PCV) vaccination regimens on the performance of pigs from weaning to slaughter in a herd with no previous clinical signs of PCV-associated disease. A total of 232 pigs was weaned at an average of 20.9 ± 0.6 d of age (BW = 14.52 lb), penned in groups of 6 to 7 pigs/pen in an offsite nursery facility and randomly assigned to 1 of 4 treatment groups. Treatment groups were: 1) No vaccination (NC); 2) 1.0 ml intramuscular (IM) injection of Boehringer Ingelheim CircoFLEX at weaning (CF); 3) 0.5 ml IM injection of Boehringer Ingelheim CircoFLEX at weaning and a 0.5 ml IM injection 3 weeks later (CF2); and 4) 2.0 ml IM injection of Intervet Circumvent PCV at weaning and a 2.0 ml IM injection 3 weeks later (IPC). At the conclusion of the nursery phase, 216 pigs (54 pigs/treatment) were transported to a growing/finishing facility. Blood samples were drawn at 4, 10, 14, and 18 weeks of age to test for PCV titers. No differences in ADG, ADFI, or F/G were observed during the nursery period ($P > 0.18$). Overall growing/finishing ADG and final BW were greater for all vaccinated pigs compared to NC ($P < 0.05$). There were no differences in ADFI or F/G during the grow-finish period ($P > 0.17$). Carcass weights were increased in all vaccinated groups compared to NC ($P < 0.05$). Pigs that tested positive for PCV titers at week 14 had decreased ADG and BW at the end of the grow-finish period ($P = 0.05$) compared to pigs that tested negative. Thus, even in an experimental herd with no previously known PCV associated disease, vaccination using any of the regimens tested greatly improved overall ADG, BW, and carcass weight.

Introduction

Porcine circovirus type 2 (PCV2) has emerged as a causative agent of postweaning multisystemic wasting syndrome (Allan et al., 1998) and has been associated with a variety of ailments including porcine respiratory disease complex, and reproductive failure (Chae, 2005). The acronym PCVAD (porcine circovirus-associated disease) has been used to encompass the various PCV2-related diseases in swine (Opriessnig et al., 2007). Clinical symptoms of PCVAD include wasting, enlargement of the lymph nodes, and difficulty breathing (Harding et al., 1998), as well as diarrhea (Kim et al., 2004). Porcine circovirus type 2 and associated diseases are reported to cause significant economic losses and increased mortality; however, Cline et al. (2008) reported that an estimated increase of over \$9 per head, less vaccination costs, was observed in pigs that were vaccinated against PCV2. Recently, several commercial PCV2 vaccines have been introduced, differing in dosage and antigen type (Opriessnig et al., 2007). The use of these PCV2 vaccines has resulted in an improvement in performance, and decrease in mortality rates (Cline et al., 2008).

The objective of this study was to evaluate the efficacy of 3 PCV2 vaccination regimens on pig growth performance, blood circovirus titers, and carcass traits in an experimental herd with no previously known incidence of PCVAD.

Experimental Procedures

Animals. For the nursery phase, 232 piglets (GPK35 × EB Ultra) from the University of Arkansas Animal Science Research Farm were transported to the University of Arkansas Offsite Nursery Facility. The animals averaged 20.9 ± 0.6 d of age at weaning and weighed 6.6 ± 0.03 kg. Weaned pigs were sorted into 5 weight blocks with stratification by sex and litter. Pigs within blocks were allotted into pens of 6 to 7 pigs per pen. Treatments were then randomly assigned to pens with 9 total replicates for each treatment. The 4 treatments

were: 1) Negative control which received no injection (NC); 2) 1.0 ml intramuscular (IM) injection of Boehringer Ingelheim CircoFLEX at weaning (CF); 3) 0.5 ml IM injection of Boehringer Ingelheim CircoFLEX at weaning followed by an additional 0.5 ml IM injection 3 weeks later (CF2); and 4) 2.0 ml IM injection of Intervet Circumvent PCV at weaning followed by an additional 2.0 ml IM injection 3 weeks later (IPC). Pigs were fed common nursery diets during Phase 1 (10 d), Phase 2 (10 d), and Phase 3 (14 d) that were formulated to meet or exceed NRC requirements for nursery pigs. Individual pig weights and pen feed intake were measured at the end of each phase in order to calculate ADG, ADFI, and F/G by phase.

At the completion of the nursery phase, pigs were moved to the University of Arkansas Growing/Finishing facility, maintaining pen identity. Pens were adjusted to 6 pigs/pen (216 pigs total) by removing the lightest pig from pens of 7 and using these pigs to replace any pigs removed from the nursery study, maintaining treatment integrity. Pigs were fed common growing/finishing diets during Phase 1 (22 d), Phase 2 (33 d), Phase 3 (30 d), and Phase 4 (19 d) that were formulated to meet or exceed NRC requirements for growing/finishing pigs. Individual pig weights were collected at the initiation of the growing/finishing period, and again at the completion of phase 4. Pen body weights were measured at the end of phases 1 through 3. Feed intake was recorded at the end of each phase. Pen ADG, ADFI, and F/G were calculated for each of the phases. Pigs were provided with feed and water *ad libitum*.

Herd Health Status. Animals used in this study originated from the University of Arkansas research herd which is historically porcine reproductive and respiratory syndrome (PRRS)- and mycoplasma-negative, with a high herd health status, low mortality rate, and no known incidence of PCV2-related symptoms. Sows received a routine pre-farrowing vaccination regimen of FarrowSure B, Litterguard LT-C, and an autogenous clostridium perfringens type A vaccine.

Serum Circovirus Titers. Blood samples were obtained via jugular venopuncture from one pig per pen (n = 9 pigs/treatment) at 4, 10, 14,

¹Department of Animal Science, Fayetteville, Ark.

²Cargill Pork, Wichita, Kan.

and 18 weeks of age. The same animals were sampled throughout the study. Samples were submitted to Boehringer Ingelheim Vetmedica (Ames, IA) for circovirus titer diagnostics using PCV2 Quantitative PCR (polymerase chain reaction). Briefly, the quantitative PCR reports the number of genomic copies per ml of serum with a lower detection level of 10^4 copies of PCV2. Each sample is compared to a quantified positive control standard curve, with results reported in a range from less than 1.0×10^4 to 9.9×10^{10} (Cline et al., 2008).

Carcass Data. At the conclusion of the study, pigs were tattooed by treatment prior to shipping. Animals were transported to a commercial slaughter facility where individual hot carcass weight, lean yield, backfat thickness, and muscle depth were determined.

Statistical Analysis. Data for ADG, ADFI, F/G, and BW were analyzed using the PROC GLM procedure of SAS (SAS Institute Inc., Cary, NC) as a randomized complete block design with treatment as the fixed effect and pen as the experimental unit. Blood circovirus titer data were evaluated using Chi square analysis and Fisher's Exact Test. Analysis of carcass data was performed using PROC GLM of SAS with the individual pig being the experimental unit.

Results and Discussion

There were no differences observed during the nursery period in ADG, ADFI, F/G, or final body weight between the treatment groups ($P > 0.18$; data not shown). These results are similar to other studies, and may be due to lack of exposure to PCV2.

During the growing/finishing period ADG was reduced in Phase 2 ($P < 0.05$), as well as the overall growing/finishing period ($P < 0.05$) in pigs receiving NC compared to those that were vaccinated, regardless of vaccination regimen (CF, CF2, or IPC; Table 1). The NC pigs were also lighter than vaccinated pigs at the end of Phase 2, Phase 3, and Phase 4 ($P < 0.05$); however, there were no differences in ADFI or F/G during the growing/finishing period ($P > 0.17$). There also were no differences among CF, CF2, and IPC in ADG, ADFI, F/G, or BW ($P > 0.22$). Thus, vaccination increased body weight beginning at the completion of Phase 2 and was maintained through the end of the study due to a nonsignificant improvement in overall ADFI and F/G.

All blood from sampled pigs ($n = 36$) was negative for PCV2 at 28 d of age. At 10 weeks of age 2 pigs had positive titers for PCV2, of which one had been vaccinated (IPC). By weeks 14 and 18 both NC

and PCV2-vaccinated pigs had positive PCV2 titers; however, there were fewer pigs with positive titers for PCV2 in the PCV2-vaccinated groups compared to NC ($P < 0.01$). Additionally, there were no significant differences between CF, CF2, and IPC in positive PCV2 titers (Fig. 1).

The presence of PCV2 titers was negatively correlated with performance in the nursery and growing/finishing periods (Table 2). Titers at 14-weeks of age were negatively correlated with overall growing/finishing ADG ($P < 0.05$), and growing/finishing end weight ($P < 0.05$). Correlations at 18-weeks of age were not different from zero ($P > 0.05$).

Pigs that were not vaccinated against PCV2 had lighter carcass weights than those that were vaccinated (90.8 vs. 95.8, 95.3, and 94.9 kg for NC, CF, CF2, and IPC respectively; Figure 2), regardless of vaccination regimen ($P < 0.05$) due to slower growth rates and final BW. However, there was no difference in carcass lean yield ($P = 0.93$), muscle depth ($P = 0.07$), or backfat thickness ($P = 0.84$) among treatments (data not shown).

Implications

Porcine circovirus type 2, and associated diseases, are detrimental to the swine industry. Vaccination against PCV2 with any of the vaccination regimens tested in this study resulted in improved performance and carcass traits. In the current study there were no differences in growth performance characteristics measured during the nursery period; however, there were marked improvements in body weight during the growing/finishing period in all vaccinated pigs as a result of a nonsignificant improvement in overall ADFI and F/G. These improvements in body weight translated into heavier carcass weight. Thus, vaccination against PCV2 should be considered to improve overall performance.

Literature Cited

- Allan, G. M., et al. 1998. J Vet. Diagn. Invest. 10:3-10.
Chae, C. 2005. Vet. J. 169:326-336.
Cline, G., V. et al. 2008. Vet. Rec. 163:737-740.
Harding, J. C. S., et al. 1998. Swine Health Prod. 6:249-254.
Kim, J., et al. 2004. Can. J. Vet. Res. 68:218-221.
Opriessnig, T., et al. 2007. J Vet Diagn Invest. 19:591-615.

Table 1. Growing/Finishing phase growth performance characteristics.

Item	NC ¹	CF ²	CF ³	IPC ⁴	SE	P-value
ADG, lb						
Phase 1	1.57	1.58	1.56	1.56	0.04	0.99
Phase 2	1.97 ^b	2.18 ^a	2.16 ^a	2.15 ^a	0.03	<0.01
Phase 3	2.49	2.58	2.58	2.56	0.04	0.36
Phase 4	2.25	2.27	2.19	2.26	0.06	0.74
Overall	2.09 ^b	2.18 ^a	2.16 ^a	2.16 ^a	0.02	0.01
ADFI, lb						
Phase 1	3.64	3.55	3.49	3.63	0.08	0.51
Phase 2	5.46	5.77	5.80	5.89	0.15	0.17
Phase 3	6.70	6.79	6.67	6.74	0.17	0.96
Phase 4	7.30	7.49	7.32	7.42	0.20	0.90
Overall	5.74	5.91	5.82	5.93	0.12	0.66
F/G						
Phase 1	2.32	2.25	2.24	2.33	0.04	0.21
Phase 2	2.77	2.65	2.69	2.74	0.06	0.68
Phase 3	2.69	2.63	2.59	2.63	0.07	0.69
Phase 4	3.24	3.30	3.34	3.28	0.12	0.93
Overall	2.75	2.71	2.69	2.74	0.05	0.82
Weight, lb						
Initial	52.6	53.7	52.4	53.0	0.7	0.68
Phase 1	87.1	88.2	86.9	87.1	1.3	0.86
Phase 2	141.0 ^b	159.9 ^a	158.2 ^a	158.2 ^a	2.0	0.05
Phase 3	226.8 ^b	237.4 ^a	235.6 ^a	235.0 ^a	2.6	0.04
Phase 4	269.7 ^b	280.5 ^a	277.0 ^a	277.9 ^a	2.4	0.02

¹Negative control, no injection²Circoflex, one-dose of 1.0 ml intramuscular (IM) at 3 weeks of age³Circoflex, two-dose of 0.5 ml IM at 3 and 6 weeks of age⁴Circumvent, two-dose of 2.0 ml IM at 3 and 6 weeks of age^{a, b}Means within a row without a common superscript are different ($P < 0.05$).

Table 2. Correlation coefficients for positive circovirus titers with average daily gain and end of growth phase body weight.

Item	14 week ¹	18 week ²	log 14 week ¹	log 18 week ²
Nursery ADG	-0.59	-0.20	-0.51	-0.14
Nursery End Weight	-0.53	-0.03	-0.60	-0.12
Growing/Finishing ADG	-0.72*	-0.16	-0.67*	0.25
Growing/Finishing End Weight	-0.73*	-0.12	-0.72*	-0.16

¹n = 10 pigs positive for circovirus titers²n = 12 pigs positive for circovirus titers* $P < 0.05$

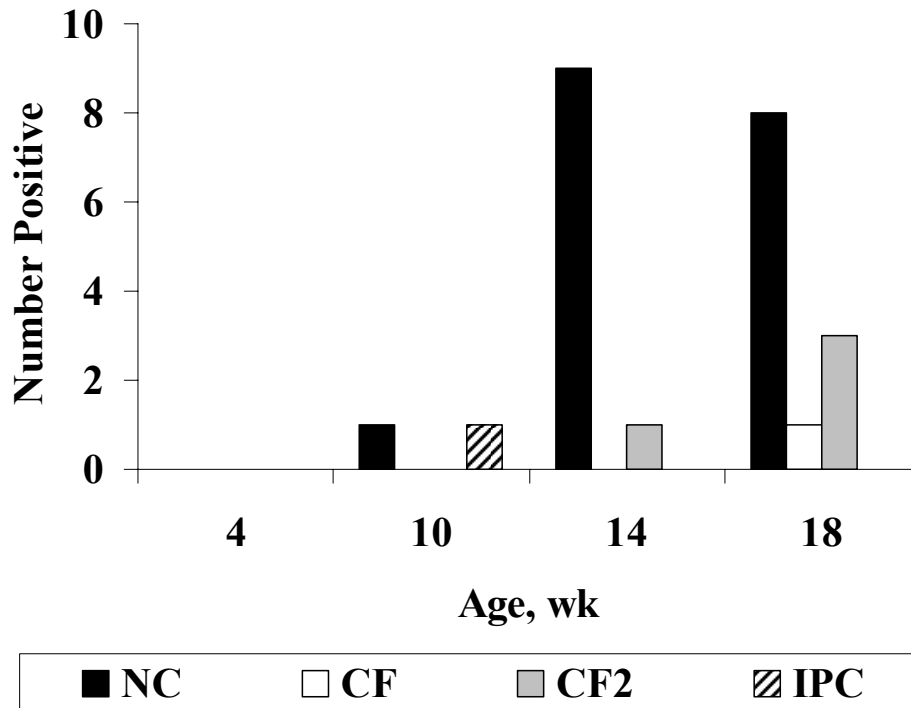


Fig. 1. Number of pigs with positive serum titers for porcine circovirus type 2 as detected by quantitative real-time polymerase chain reaction (PCR) at 4, 10, 14, and 18 weeks of age (n = 9/trt). Treatment consisted of either 1) no vaccination (NC); 2) a single 1.0 ml intramuscular (IM) injection with Boehringer Ingelheim Circoflex at 3 wk of age; 3) a 0.5 ml IM injection with Boehringer Ingelheim Circoflex at 3 wk and 6 wk of age; or 4) a 2.0 ml IM injection with Boehringer Ingelheim Circoflex at 3 wk and 6 wk of age.

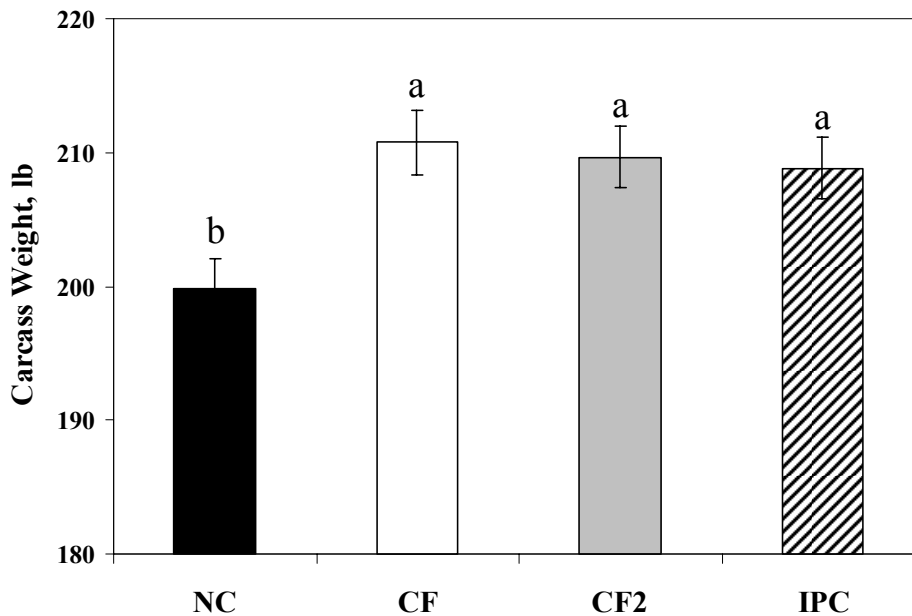


Fig. 2. Carcass weight of pigs that received either 1) no vaccination (NC); 2) a single 1.0 ml intramuscular (IM) injection with Boehringer Ingelheim Circoflex at 3 wk of age; 3) a 0.5 ml IM injection with Boehringer Ingelheim Circoflex at 3 wk and 6 wk of age; or 4) a 2.0 ml IM injection with Boehringer Ingelheim Circoflex at 3 wk and 6 wk of age. ^{a, b} $P < 0.05$.