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Effects of Environmental Factors on Death Rate of Pigs in South Korea

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Reducing the mortality rate among pigs for a swine industry is very important. In this study, environmental factors such as average air temperature, average daily temperature rage and average relative humidity were determined on its effects of on mortality rate of pigs and its optimum ranges to influence pigs health that were correlated with the pigs periodic growth. Data were collected from 10 pig farms in South Korea during the Summer, Fall and Winter seasons. Correlation and regression equation between each environmental factor and pigs' death rate and correlation between pigs' mortality rates of different rearing stages were analyzed. Mortality rate of young pigs (suckling piglets and weaning piglets) was susceptibly affected by the average air temperature and daily air temperature range, but not by average relative humidity. It was observed in this study that the recommended daily air temperature for young pigs is below 1.5˚C. The positive correlation between pigs' mortality rates of different rearing stage indicated that pigs need to be reared in a good and appropriate environment from starter to finisher.

INTRODUCTION

With the economic growth in Korea, consumers' demand for pork products steadily increased. Due to the higher consumption of pork, the average number of pigs reared in a farm has increased. With the existing small scale Korean pig farms, establishment of additional larger pig farms has also been encouraged (National Agricultural Products Quality Management Service in Republic of Korea, 2007). Present problems in pig farms consisted of high mortality rates as affected by some environmental factors resulting to loss of productivity. The mortality rate of pigs in Korea is too high which ranges from 5 to 40% (Korean Association of Swine Veterinarians, 2006).

Some of the factors that affect the mortality of pigs include air temperature, daily temperature range, relative humidity, air qualities and etc. in pig houses (MidWest Plan Service, 1977; Waths and Charls, 1994). The indoor air temperature below the lower critical temperature and a wide daily temperature range may reduce growth, feed efficiency and immune ability of pigs and the reduction of immune ability may increase mortality rate (Waths and Charls, 1994). Higher temperatures and relative humidity above 80% could enhance pathogenic organism survival and thus induces more bacterial diseases. However relative humidity below 40% may contribute to excessive dustiness. Dust can play a role as a respiratory irritant and a conveyance mechanism for pathogens to the respiratory tract of pigs. As the concentration of dust is higher, respiratory diseases may be more induced (American Society of Agricultural Engineers, 1995).

Considering the findings mentioned above, in order to reduce mortality rate of pigs, we need to know effects of environmental factors on mortality rate of pigs and find the optimum ranges of these factors to improve the growth of swine at every rearing stages. However the effects of these environmental factors on swine mortality as well as the optimum ranges of these factors for proper growth and development of swine has not yet been reported. Therefore this paper would like to show the effects of various environmental factors such as air temperature, daily temperature, and relative humidity on the mortality rate in swine and recommend ideal environment for different rearing stages of pigs to avoid higher mortality rate in intensive pig farming.

MATERIALS AND METHODS

Climate of the experimental region

This study was conducted from 10 swine farms which were located in Jinju and Goseong of South Korea. The

Table 1. Data of the different climatic periods in the experimental pig farm (2010)

Item	Spring	Summer	Fall	Winter
Mean temperature (˚C)	12.3	24.1	14.5	4.1
Maximum temperature (˚C)	24.0	30.2	26.5	9.3
Minimum temperature (˚C)	0.6	16.9	2.0	–5.3
Mean relative humidity (%)	66.8	79.8	74.3	65.0

Reference: Korea Meteorological Administration, 2010.

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climate data of the experimental region is shown in Table 1. It shows winter is the coldest and summer is the hottest for the piglets. Moreover, it shows that there is a wide range in daily temperature in spring and fall especially for piglets. Relative humidity is generally at the optimum range in spring, fall and winter but very high in summer.

Animals and treatment

The breeding pigs used in this study were Yorkshire x Landrace crossbreds (YL) and Landrace x Yorkshire crossbreds (LY) which were mainly raised in South Korea. They were artificially inseminated with semen of Duroc boars during estrus. The first insemination of the gilts was done at average age of 240 days. All pregnant pigs were fed 1.3 to 1.5 kg commercial ration (12.56 MJ metabolizable energy kg^{-1}, crude protein 144 g kg^{-1}, ideal digestible lysine 7.5 g kg^{-1}), twice daily at 07:30 and 16:30. The animals were moved to the farrowing units 7 days prior to farrowing. All of them were fed a standard ration of commercial concentrate (Jeon *et al*., 2006), three times a day at 08:00, 13:00, and 18:00. On the day of farrowing, sows received 1 kg of diet and the ration was increased by 0.8 kg day^{-1} on day 1 and 2, and 1 kg day^{-1} on day 3 and 4, with free access to feed from day 5 until weaning on 21 days. The sows always had ad libitum access to an operant water nipple.

Some suckling piglets were cross–fostered within 24 hours postpartum so that litters can be just limited up to 9 to 12 piglets. All sucklings undergo teeth clipping and tail docking on the 1st day postpartum and male sucklings were castrated when they were 3 days old. Suckling's were fed creep feeds 4 to 6 times a day from day 7 until weaning.

All weaning piglets, growing pigs, and fattening pigs were fed a commercial standard ration concentrate which is in accordance of the nutrient requirements recommended by Cromwell *et al*. (1998). The vaccination schemes of 10 farms were under same condition; hog cholera virus, parvo virus, erysipelas and atrophic rhinitis in sow and swine epidemic pneumonia, cholera virus, porcine circo virus–2 and erysipelas in post–weaning pigs.

Housing and environment

The pregnant pigs were transferred approximately 7 days prior to farrowing to each individual farrowing houses (240×160 cm) with slatted floors. The size of the farrowing crates in the pens was 210×60 cm. All the farrowing houses were mechanically ventilated by exhaust fans, based on the recommended ventilating rate for sows and their litters (Fehr and Huhnke, 2001). An infrared lamp (250 W) was installed above each creep area. It was turned on when room temperature was below 30°C from the estimated farrowing day until weaning of 21 days.

The weaning piglets were housed (2.4×1.4 m house (0.3 m^2 head^{-1})) for about 46 days in a windowless house which had proper thermal resistance values and were mechanically ventilated by exhaust fans, based on the recommended ventilating rate for weaning piglets (Fehr and Huhnke, 2001). An infrared lamp (250 W) was installed in each house. It was turned on by a farmer when room temperature was observed below or within the critical temperature (Hoff, 2001).

The growing pigs and fattening pigs were housed in a 3.6×2.5 m (0.6 m^2 head^{-1}) and 5×3 m (0.9 m^2 head^{-1}) pens respectively for about 53 days for the growing pigs and until marketing stage for fattening pigs. Both growing and fattening pigs were housed either in a windowless or not–windowless housing. Both were mechanically ventilated by exhaust fans, based on the recommended ventilating rate (Fehr and Huhnke, 2001).

Measurements

All the data were collected from June to December 2009 (during summer, fall, and winter). Thermometers (Daekwang Instrument Inc., Min & Max thermometer, South Korea), which could measure the lowest temperature and the highest temperature of daily temperatures, and hygrometers (Nice Meter, Model No. NM–160, South Korea) were installed in the farrowing, weaning, growing, and fattening houses of each pig farms. Temperature and relative humidity were checked three times a day at 08:00, 14:00, and 18:00 by farmers during the entire experimental period. Data of pigs' death rate by house were collected based on the daily recorded number of dead pigs of the farmer.

Statistical analysis

Correlation and regression between average temperature and pigs' death rate, correlation and regression between average daily temperature rage and pigs' death rate, correlation and regression between average relative humidity and pigs' death rate, and correlation between pigs' death rates of each raising step were analyzed by using Microsoft Office Excel 2007 (Microsoft Inc, USA).

RESULTS AND DISCUSSION

Table 2 summarizes air temperature, daily air temperature range, relative humidity and death rate which were collected from 10 pig farms in South Korea. In fallowing pig houses, average air temperatures were 31.7°C in summer, 24.4°C in fall and 21.9°C in winter. Average daily air temperature ranges were 3.3°C in summer, 3.7°C in fall and 3.9°C in winter. In the same year, average relative humidities were 62.5% in summer, 57.3% in fall and 63.0% in winter. Average death rates were 4.2% in summer, 4.4% in fall and 4.6% in winter. While season changed summer to winter, average air temperature consistently decreased whereas average daily air temperature range and average relative humidity consistently increased. Trends of average relative humidity did not vary with different climatic periods.

In weaning piglet houses, average air temperatures were 30.1°C in summer, 26.7°C in fall and 27.0°C in winter. Average daily air temperature ranges were 3.5°C in summer, 3.0°C in fall and 3.1°C in winter. Average relative humidities were 63.2% in summer, 60.9% in fall and 64.4% in winter. Average mortality rates were 3.1% in summer, 3.5% in fall and 3.3% in winter. Average air temperatures and average daily air temperature ranges in summer were higher when compared to other seasons. Average relative humidity did not also show a consistent trend.

In growing pig houses, average air temperatures were 29.0°C in summer, 27.0°C in fall and 23.4°C in winter. Average daily air temperature ranges were 4.5°C in summer, 4.0°C in fall and 3.9°C in winter. At similar year, the average relative humidities were 64.5% in summer, 62.9% in fall and 65.1% in winter. Average mortality rates were 2.2% in summer, 2.4% in fall and 2.1% in winter. With the season that changes from summer to winter, the average air temperature and average daily air temperature also dramatically decreased. Average relative humidity did not also show a consistent trend.

In fattening pig houses, average air temperatures were 29.1°C in summer, 26.1°C in fall and 22.9°C in winter. Average daily air temperature ranges were 4.6°C in summer, 3.9°C in fall and 4.0°C in winter. Average relative humidities were 64.3% in summer, 63.1% in fall and 65.4% in winter. Average death rates were 1.5% in summer, 1.7% in fall and 1.4% in winter. When the season changed from summer to winter, average air temperature consistently decreased and average daily air temperature range in summer was higher than fall and winter but average relative humidity did not show a consistent trend.

Table 3 shows correlations between each environmental factor and mortality rate which were collected in the pig houses of 10 farms in South Korea. Correlations between average air temperature and mortality rate of weaning pig houses were high in fall (0.7069) and winter (0.5647) except for summer, whereas those of other pig houses were low. Correlations between average daily air temperature range and death rate of farrowing and weaning pig houses were high (over 0.3209) in all seasons, whereas those of other pig houses were low in all seasons. All of correlations between average relative humidity and death rate were low in all pig houses and in all seasons. Therefore, it is recommended to precisely control the air temperature within thermoneutral zone with a very small daily air temperature range in order to minimize mortality rate in farrowing and weaning stages.

Table 2. Air temperature, daily air temperature range, relative humidity and death rate in pig houses

Type	Season	Air temperature (°C)	Daily air temperature range (°C)	Relative humidity (%)	Death rate of suckling piglets (%)
Fallowing pig	Summer	28.1±1.7	3.3±1.1	59.7±4.8	4.2±2.0
	Fall	24.4±0.9	3.7±1.1	57.3±4.6	4.4±2.4
	Winter	21.9±1.4	3.9±0.9	63.0±5.0	4.6±2.7
Weaning piglet	Summer	30.1±1.3	3.5±2.5	63.2±5.1	3.1±1.1
	Fall	26.7±0.8	3.0±1.0	60.9±4.3	3.5±1.9
	Winter	27.0±0.7	3.1±1.2	64.4±5.1	3.3±1.2
Growing pig	Summer	29.0±1.2	4.5±1.6	64.5±6.2	2.2±1.4
	Fall	27.0±0.9	4.0±1.1	62.9±5.8	2.4±1.7
	Winter	23.4±0.9	3.9±3.5	65.1±4.0	2.1±1.2
Fattening pig	Summer	29.1±1.2	4.6±1.6	64.3±6.1	1.5±1.6
	Fall	26.1±1.0	3.9±1.3	63.1±5.5	1.7±1.7
	Winter	22.9±0.9	4.0±1.3	65.4±5.5	1.4±1.3

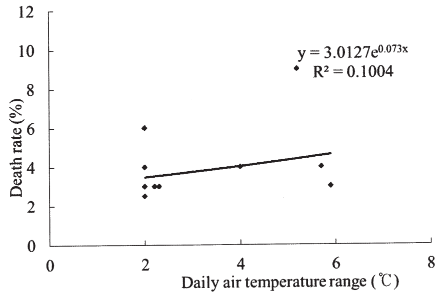
Table 3. Results of correlation analysis from data of pig houses

Season	Environmental factor	Death rate			
		Suckling piglets	Weaning piglets	Growing pigs	Fattening pigs
Summer	Average air temperature	0.162	0.2019	0.1864	0.2704
	Average daily air temperature range	0.3209	0.6498	–0.2419	–0.0472
	Average relative humidity	–0.3462	0.2239	0.0737	0.0759
Fall	Average air temperature	0.1831	0.7069	0.1933	–0.2007
	Average daily air temperature range	0.5851	0.6723	–0.223	0.067
	Average relative humidity	–0.4485	0.0736	–0.1591	0.0119
Winter	Average air temperature	0.06	0.5647	–0.0241	–0.3209
	Average daily air temperature range	0.7603	0.7094	–0.1703	–0.1682
	Average relative humidity	–0.0122	–0.2409	–0.1847	–0.0704

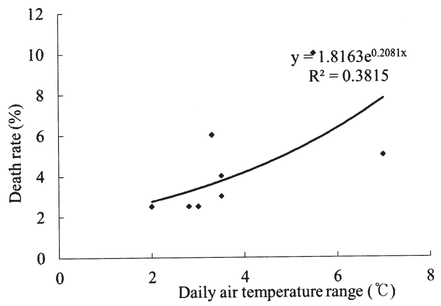
These findings were also observed from the previous studies (Waths and Charls, 1994).

Fig. 1 and Fig. 2 show relationship and regression equation between daily air temperature range and mortality rate of young piglets in farrowing pig houses and weaning piglet houses, respectively. As indoor daily air temperature range is increase to above 1.5°C, death rate of young pigs increases. This finding is similar to the previous results that indoor daily air temperature range to keep young pigs healthy is below 2°C (American Society of Agricultural Engineers, 1995; Hahn *et al*., 1987; Ogilvie, 1993). Fig. 3 shows relationship and regression equation between average air temperature and death rate of weaning piglets in weaning piglet houses. As average air temperature increases, death rate of young pigs also increases. In general, to keep average air temperature higher means lower ventilating rate and worse air quality, whereas to keep average air temperature lower means higher ventilating rate and better air quality. Due to this, houses in that young pigs has been rearing must be properly ventilated, maintaining air temperature slightly higher than lower critical temperature with daily air temperature range below 1.5°C. This result is similar to some previous findings (MidWest Plan Service, 1977; Waths and Charls, 1994).

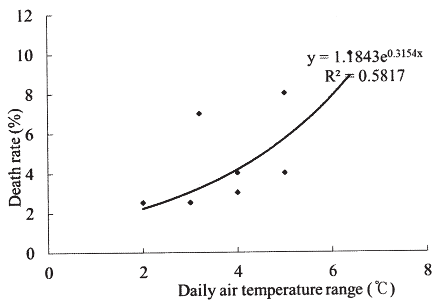
Table 4, Table 5, and Table 6 summarize the results of correlation analysis among raising stages in summer, fall and winter. Correlations between death rate of suckling piglets and death rate of weaning piglets and between death rate of weaning piglets and death rate of growing pigs were high in all seasons. And correlation between death rate of growing pigs and death rate of fattening pigs was high in summer and fall except for winter. Therefore, pigs must be reared in good environment from youth to market.



a) Summer

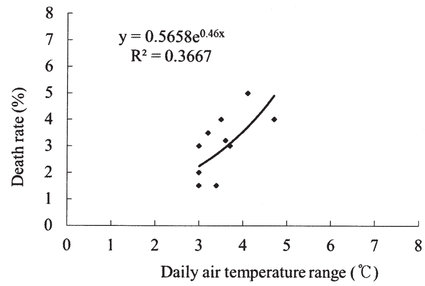


b) Fall

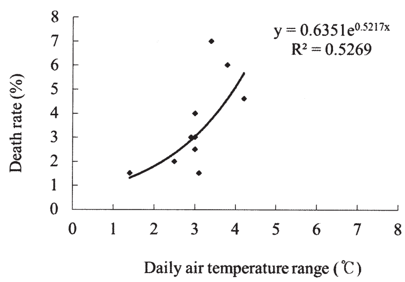


c) Winter

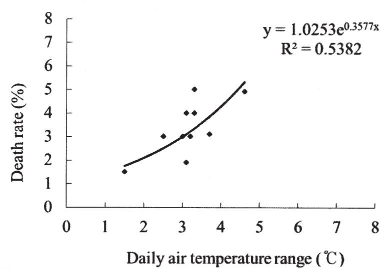
Fig. 1. Relationship and regression equation between daily air temperature range and death rate of suckling piglets in farrowing pig houses.



a) Summer



b) Fall



c) Winter

Fig. 2. Relationship and regression equation between daily air temperature range and death rate in weaning piglet houses.

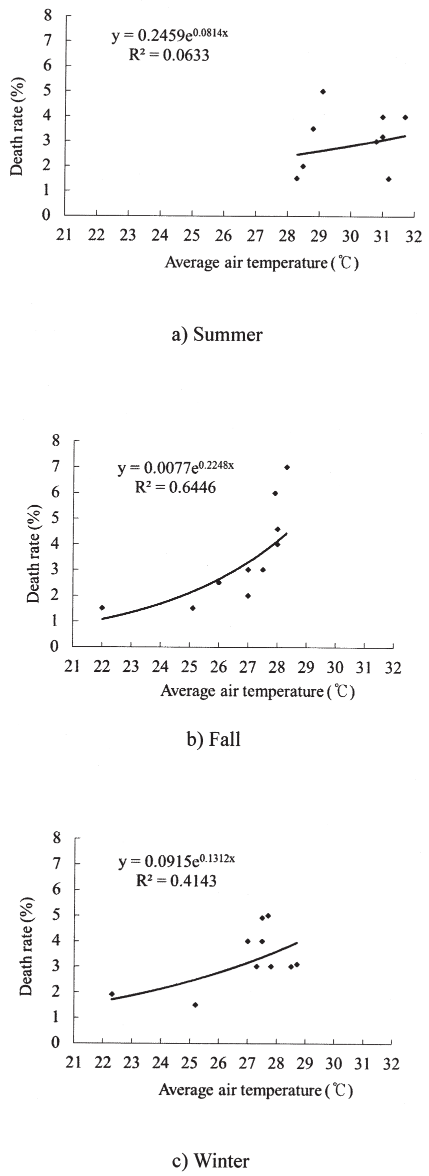


Fig. 3. Relationship and regression equation between average air temperature and death rate in weaning piglet houses.

Table 4. Results of correlation analysis among raising stages in summer

Item	Death rate of suckling piglets	Death rate of weaning piglets	Death rate of growing pigs	Death rate of fattening pigs
Death rate of suckling piglets	1	0.303	0.0006	–0.064
Death rate of weaning piglets	0.303	1	0.6828	0.4242
Death rate of growing pigs	0.0006	0.6828	1	0.8926
Death rate of fattening pigs	–0.064	0.4242	0.8926	1

Table 5. Results of correlation analysis among raising stages in fall

Item	Death rate of suckling piglets	Death rate of weaning piglets	Death rate of growing pigs	Death rate of fattening pigs
Death rate of suckling piglets	1	0.7257	0.6497	0.3909
Death rate of weaning piglets	0.7257	1	0.6689	0.3909
Death rate of growing pigs	0.6497	0.6689	1	0.9097
Death rate of fattening pigs	0.3909	0.3909	0.9097	1

Table 6. Results of correlation analysis among raising stages in winter

Item	Death rate of suckling piglets	Death rate of weaning piglets	Death rate of growing pigs	Death rate of fattening pigs
Death rate of suckling piglets	1	0.3813	0.2647	-0.0669
Death rate of weaning piglets	0.3813	1	0.4116	0.0999
Death rate of growing pigs	0.2647	0.4116	1	0.0999
Death rate of fattening pigs	-0.0669	0.0999	0.9097	1

CONCLUSIONS

This study was carried out to investigate the effects of In this study, environmental factors such as average air temperature, average daily temperature rage and average relative humidities were determined on its effects of on mortality rate of pigs and its optimum ranges to influence pigs health that were correlated with the pigs periodic growth. Data were collected from 10 pig farms in South Korea during the Summer, Fall and Winter seasons. Correlation and regression equation between each environmental factor and pigs' death rate and correlation between pigs' mortality rates of different rearing stages were analyzed. Indoor environment of pig house and pigs' death rate were affected by season. Especially, mortality rate of young pigs was susceptibly affected by average air temperature and daily air temperature range. It is suggested that young pigs required daily air temperature that is lower than 1.5°C. Correlation between pigs' death rates of each raising stage was high. Thus pigs must be reared in good environment from youth to market.

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