PARTIAL DIALLEL CROSS ANALYSIS AMONG THREE BREEDS OF PIG FOR PRODUCTIVE AND REPRODUCTIVE TRAITS

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Abstract
Suatu penelitian telah dilakukan untuk mengevaluasi general combining ability (GCA) dan specific cobining ability (SCA) untuk sifat produksi dan reproduksi pada babi. Materi yang digunakan adalah catatan keturunan hasil persilangan tiga bangsa babi (Duroc, Landrace, Yorkshire) sebanyak 573 anak babi yang berasal dari 13 pejantan dan 65 induk. Formula yang digunakan untuk menganalisis parameter adalah Partial Diallel Cross Metode II dari Griffings. Parameters yang diamati pada anak adalah litter size, bobobt lahir, jumlah puting, pertambahan bobot badan (PBB) sebelum dan sesudah sapih dan bobot sapih. Hasil penelitian menunjukkan bahwa GCA Duroc lebih tinggi dibandingkan Yorksire and Landrace, yang nilai GCA untuk litter size, bobot lahir, jumlah puting, jumlah anak pada saat sapih, bobot sapih, PBB sebelum sapih, PBB setelah sapih dan bobot badan pada umur 42 hari masing-masing -0,18; -0,02; -0,52; -0,13; -0,21; -0,01; 0,01 dan 0,03. Persiilangan antara ♂ Duroc x ♀ Yorkshire menunjukkan SCA paling tinggi untuk bobot lahir (0.30), jumlah puting (3.60), bobot sapih (1.10) dan PBB sebelum sapih (0.04). Persilangan antara ♂ Yorkshire x ♀ Landrace menghasilkan SCA paling tinggi untuk litter size (2.47), jumlah anak waktu sapih (2.23), PBB sebelum sapih (0.04), PBB setelah sapih (0.06) and bobot badan pada umur 42 hari (2.30). Kesimpulan penelitian ini adalah nilai paling baik untuk GCA ditunjukkan oleh Duroc, sementara itu SCA oleh persilangan antara ♂ Yorkshire x ♀ Landrace.

Kata kunci: partial diallel cross, babi, sifat produksi, sifat reproduksi

1. INTRODUCTION

Genetic improvement can be accomplished when genetically superior individuals are selected and then mated to reproduce the next generation. The real genetic merit of individuals are never known but can be estimated from the available data. A measure of the progress in breeding pig performance over time can be gained from an examination of crossing model. One of the several biometrical techniques available to animal breeders for evaluating and characterizing genetic variability existing in a animal species was diallel analysis (Singh and Paroda, 1984; Purwanti *et al*, 2009).

The diallel cross is a good genetic tool for evaluating the performance of lines and breeds in crossbreeding combinations (Eisen, 1983). Diallel mating designs are an important tool in animal breeding programs to obtain information on inheritance, such as general combining ability (GCA) and specific combining ability (SCA), of quantitative or complexly inherited traits (Zhang *et al*., 2005; Saadey *et al.*, 2008). GCA is an estimate of the average performance of a genotype in hybrid combinations, and is related to the proportion of additive genetic variability. GCA for a particular genotype is measured as the deviation of its progeny mean from the mean of all the lines used. Meanwhile, SCA estimates how progeny from a specific cross perform in relation to what would be expected based on the average performance of the genotypes involved (Murphy *et al*., 2008). SCA effects are caused by dominance, epistasis or both gene effects acting simultaneously (Hill *et al*., 1998).

Diall cross is classified into complete diallel cross and partial diallel cross. Until now there has been limitation of information on the experiment of diallel cross, especially in pig.

Diterima 6 Pebruari 2010; terima dalam revisi 11 Maret 2010; layak cetak 5 April 2010

Therefore, a study on partial diallel cross is important. Because of limited materials of breeds in crossing combination conducted simultaneously, a partial diallel cross was usual used. The objective of the study was to analyze the combining ability (GCA) and specific cobining ability (SCA) of productive and reproductive traits in pig.

2. MATERIALS AND METHODS

The materials used in this study was performance recording data of 573 piglets originating from 13 boars and 65 gilts. Each of parent comprises 7 of boars Duroc, 4 of boars Yorksire, 2 of boars Landrace, 10 of gilts Duroc, 21 of gilts Yorksire, and 34 of gilts Landrace. The data was the recording obtained during July to September 2008 at PT. Cemara Sewu.

The observed object in this study was the piglet from partial diallel cross from 3 breed of pig, respectively: (1) ♂ Duroc x ♀ Duroc; (2) ♂ Duroc x ♀Yorkshire ; (3) ♂ Duroc x ♀ Landrace ; (4) ♂ Yorkshire x ♀ Yorkshire ; (5) ♂ Yorkshire x ♀ Landrace ; (6) ♂ Landrace x ♀ Landrace. The piglet was from the Parity I at PT. Cemara Sewu. Banjarmulya, Pemalang, Central Java. Diallel cross method II (reciprocals excluded, parents included) was used as a crossing system as presented Table 1.

Table 1. Partial Diallel Cross of Three Breeds of Pig

♀ \ ♂	D (Duroc)	Y (Yorkshire)	L (Landrace)
D (Duroc)	♂ D x ♀D {2 : 10} (n=81)	♂ D x ♀Y {2 : 11} (n=102)	♂ D x ♀ L {3 : 12} (n=105)
Y (Yorkshire)		♂ Y x ♀ Y {2 : 10} (n=91)	♂ Y x ♀ L {2 : 12} (n=115)
L (Landrace)			♂ L x ♀ L {2 : 10} (n=79)

n : the number of piglets

The prosedure of observation was explained as follow: 1) parity I was choosen in this research, 2) each of pregnant sow was placed at individual cage until piglet born, 3).the piglet was weaned at 21 days, 4) piglet was observed from birth 42 days, and data obtained was tabulated and arranged according to each crossing .

Parameters observed

a. Litter size was the offspring produced at one birth of sow from each crossing.
b. Birth weight was the weight of born piglet.
c. Number of nipples was the total of nipple from each piglet.
d. Number of piglets at weaning was the total of living piglet in the end of weaning period.
e. Weaning weight was the weight of piglet when weaned at 21 days
f. Average daily gain (ADG) pre weaning was the gained of body weight from birth to weaning from each crossing.
g. Post weaning ADG was the gain of body weight after weaning to 42 days of age.
h. Mortality at 42 days was measured by the formula below:

$$\frac{\text{piglet' s mortality until 42 days}}{\text{litter size}} x100\%$$

i. Body weight at 42 days

Data was analyzed by using partial diallel cross of method II of Griffing (1956). The formula used to analysis was as follows:

$$\hat{g}_i = \frac{1}{p+2}(X_{i\bullet} + x_{ii} - \frac{2}{p}X_{\bullet\bullet})$$

$$\hat{S}_i = x_{ij} - \frac{1}{p+2}\left(X_{i.} + x_{ii} + X_{j.} + x_{jj}\right) + \frac{2}{(p+1)(p+2)}X_{..}$$

where:

$\hat{g}_i$ = general combining ability value for i^{th} linebred

$\hat{s}_{ij}$ = specific combining ability for "crossbred" of the i^{th} sire and the j^{th} dam

P = total of inbred line

$$X_{i.} = \sum_j x_{ij} = x_{i1} + x_{i2} + x_{i3}$$

$$X_{..} = \sum\sum_{i \le j} x_{ij} = x_{11} + x_{21} + x_{22} + x_{31} + x_{32} + x_{33}$$

x_{ij} = the offspring from crossing between sire of the i^{th} linebred with dam of the j^{th} linebred

x_{ii} = The offspring from crossing between sire of the i^{th} linebred with dam of the i^{th} linebred

x_{jj} = The offspring from crossing between sire of the j^{th} linebred with dam of the j^{th} linebred

$$X_{j\bullet} = \sum_i x_{ji} = x_{j1} + x_{j2} + x_{j3}$$

3. RESULTS AND DISCUSSION

Table 2 presents the combining ability value Based on Table 2 can be seen that the of productive and reproductive traits. It can be seen that GCA on litter size of Duroc (g_1) was -0.18;

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Yorkshire (g_2): -1.47 and Landrace (g_3): -3.87. Duroc had the greatest GCA for litter size compared to Yorkshire and Landrace. The greatest GCA value on Duroc could be expected that Duroc breed had a ability breed to give better litter size in their offspring. The highest SCA value could be reached on crossing of ♂ Yorkshire x ♀ Landrace with the value of 2.47, whereas the *SCA* value on crossing of ♂ Duroc x ♀Yorkshire was 2.20 and the crossing of ♂ Duroc x ♀ Landrace was 0.35. The highest value of crossing on ♂ Yorkshire x ♀ Landrace was caused by gen interaction producing a new phenotype from that crossing. Van Vleck et al. (1987) stated that the crossing between breed of animal enabled to produce gen interaction causing an appearing of new phenotype.

Table 2. Combining Ability Value of Productive and Reproductive Traits in Pig

Parameter	Combining Ability					
	g_1	g_2	g_3	$S_{1.2}$	$S_{1.3}$	$S_{2.3}$
Litter Size	-0.18	-1.47	-3.87	2.20	0.35	2.47
Weight Birth	-0.02	-0.31	-0.60	0.30	0.00	0.28
Number of Nipples	-0.52	-2.61	-5.43	3.60	0.38	2.72
Number of Piglets at Weaning	-0.13	-1.41	-3.39	2.16	0.11	2.23
Weaning Weight	-0.21	-0.89	-1.99	1.10	0.03	1.03
ADG Pre Weaning	-0.01	-0.03	-0.07	0.04	0.00	0.04
ADG Post Weaning	0.01	-0.07	-0.13	0.05	0.01	0.06
Mortality	0.00	-0.02	-0.06	0.04	0.02	0.02
Body Weight at 42 days	0.03	-2.36	-4.84	2.23	0.33	2.30

g1 : GCA value of Duroc, g2 ; GCA value of Yorkshire, g3 ; GCA value of Landrace, $S_{1.2}$. : SCA value of ♂ Duroc x ♀Yorkshire, $S_{1.3}$: SCA value of ♂ Duroc x ♀ Landrace, $S_{2.3}$: SCA value ♂ Yorkshire x ♀ Landrace.

GCA value for the parameter of birth weigh on Duroc (g_1), Yorkshire (g_2), Landrace (g_3) were 0.02; -0.31 and 0.60, respectively. This mean that Duroc had more ability in passing the better birth weight trait to the offspring than that of others.

Crossing of ♂ Duroc x ♀Yorkshire had the highest SCA value than that of crossing of ♂ Duroc x ♀ Landrace and ♂ Yorkshire x ♀ Landrace. This condition showed that crossing of ♂ Duroc x ♀Yorkshire was estimated to produce the highest birth weight than crossing of ♂ Duroc x ♀ Landrace and ♂ Yorkshire x ♀ Landrace.

On the number of nipples parameter, GCA value on Duroc (g_1), Yorkshire (g_2) and Landrace (g_3) were -0.52; -2.61 and -5.43, respectively. Duroc had higher GCA value on the number of nipples. The higest value of GCA reached when it was crossed to Yorkshire. The Good genotype might have been derived from the highest GCA value of crossing (Maurya and Singh, 1997).

The GCA value of number of piglets at weaning on Duroc (g_1), Yorkshire (g_2) and Landrace (g_3) were -0.13; -1.41 and -3.39, respectively. This condition stowed that estimation of the highest GCA was the Duroc. If it was crossed to Yorkshire and Landrace, the result showed that GCA value lower than that of crossing of ♂ Yorkshire x ♀ Landrace. Schilling *et al*. (1968) stated that there was possibility of higher GCA value whereas there was a lower SCA value. The higher GCA and SCA indicate the higher of genotype produced certain traits, but sometimes the higher of GCA did not show in higher SCA. It was due to the interaction effect, in which crossing between two breeds of animal could cause new performance in the offspring.

GCA value for weaning weight parameter on Duroc (g_1), Yorkshire (g_2) and landrace (g_3) were -0.21; -0.89 and -1.99, respectively. Estimation of GCA value for weaning weight on Duroc was the highest than Yorkshire and Landrace. The same result has been shown in SCA value. Crossing of ♂ Duroc x ♀Yorkshire had the highest value of SCA than the other crossing. It was mean that crossing of ♂ Duroc x ♀Yorkshire was estimated to produce the higher weaning weight compared with the crossing of ♂ Duroc x ♀ Landrace and ♂ Yorkshire x ♀ Landrace. According to Hill *et al.* (1998), appearing of *SCA* was caused by dominant gen, epistasis, or influence of the both of gen appearing together.

GCA value of pre weaning ADG on Duroc (g_1), Yorkshire (g_2) and landrace (g_3) were -0.01, -0.03 and -0.07, respectively. The highest of GCA for pre weaning ADG was the Duroc. Based on the SCA analysis, crossing of ♂ Duroc x ♀Yorkshire and ♂ Yorkshire x ♀ Landrace showed the similar value, that was 0.04; whereas the crossing of ♂ Duroc x ♀ Landrace had the lower SCA value (0,00). The higher of SCA value crossing of ♂ Duroc x ♀Yorkshire was caused by the higher of GCA value of Duroc. A better genotype might have been derived from crossing parent that had higher GCA (Maurya and Singh, 1997). Crossing of ♂ Yorkshire x ♀ Landrace showed the higher SCA.

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GCA value of post weaning ADG on Duroc (g_1), Yorkshire (g_2) and landrace (g_3) were 0.01; -0.07; and -0.13, respectively. Duroc was the highest on estimation of GCA value. The different thing was showed in SCA value. The highest SCA was showed in the crossing of ♂ Yorkshire x ♀ Landrace compared to crossing of ♂ Duroc x ♀ Landrace and ♂ Yorkshire x ♀ Landrace. Hill *et al*. (1998) stated that the higer SCA was caused by influence of the both of genes appearing together.

The GCA estimation value body weight of 42 days on Duroc (g_1), Yorkshire (g_2) and landrace (g_3) was 0.03; -2.36; and -4.84, respectively. The different thing showed in SCA value. The higher SCA was showed by crossing of ♂ Yorkshire x ♀ Landrace compared to crossing of ♂ Duroc x ♀ Yorkshire and ♂ Duroc x ♀ Landrace. It menas that there was an interaction of gene causing an appearing of new phenotype and expected to have an ability in passing a better body weight trait of 42 days old to the offspring.

4. CONCLUSION

In conclusion, GCA of Duroc was higher than that of Yorksire and Landrace on litter size, birth weight, the number of nipples, the number of piglets at weaning, weaning weight, pre weaning ADG, post weaning ADG, and body weight at 42 days. Crossing ♂ Duroc x ♀ Yorkshire was the highest SCA on birth weight, the number of nipples, the weaning weight, and ADG pre weaning. Crossing ♂ Yorkshire x ♀ Landrace was the highest SCA on litter size, the number of piglets at weaning, pre weaning and post weaning ADG, and body weight at 42 days.

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Diterima 6 Pebruari 2010; terima dalam revisi 11 Maret 2010; layak cetak 5 April 2010