Journal of the Indonesian Tropical Animal Agriculture
(J. Indonesian Trop. Anim. Agric.)
pISSN 2087-8273 eISSN 2460-6278
41(2):61-69, June 2016
DOI: 10.14710/jitaa.41.2.61-69

ESTIMATION OF SELECTION ACCURACY AND RESPONSES OF THE PRODUCTION CHARACTERISTICS USING DIFFERENT SELECTION INTENSITY IN MAGELANG DUCK

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Received April 22, 2016; Accepted May 13, 2016

ABSTRAK

Penelitian bertujuan untuk menduga respon dan kecermatan seleksi karakteristik bobot tetas, pertumbuhan dan produksi telur menggunakan intensitas seleksi yang berbeda pada itik Magelang. Materi penelitian adalah itik Magelang sebanyak 408 ekor terdiri atas 8 ekor pejantan, 40 ekor induk dan 360 ekor keturunannya. Metode penelitian yang digunakan adalah eksperimen dengan rancangan percobaan pola tersarang, pejantan sebagai perlakuan, induk sebagai sub perlakuan, anak sebagai ulangan dan karakteristik produktif sebagai pengamatan. Sembilan ekor *day old duck* (dod) dari setiap induk diukur bobot tetas dan pertumbuhannya sampai umur 8 minggu. Produksi telur yang diukur adalah *Hen Day Production* (HDP) pada periode peneluran awal selama 90 hari. Hasil penelitian menunjukkan bahwa dengan menggunakan intensitas seleksi berbeda (25, 50 dan 75 persen) diperoleh respon per generasi pada karakteristik bobot tetas masing-masing 2,968; 1,870 dan 0,982 g; karakteristik pertumbuhan masing-masing 0,00221; 0,00139 dan 0,00073 g sedangkan produksi telur masing-masing 1,728; 1,088 dan 0,571%. Kecermatan seleksi untuk karakteristik bobot tetas, pertumbuhan dan poduksi telur masing-masing 0,70 0,76 dan 0,51. Berdasarkan hasil penelitian dapat disimpulkan bahwa semakin sedikit proporsi induk yang dipertahankan maka semakin tinggi nilai intensitas seleksinya, se hingga respon seleksi yang diperoleh juga semakin tinggi. Kecermatan seleksi pada karakteristik produktif ditentukan oleh nilai heritabilitasnya.

Kata kunci: Respon seleksi, intensitas seleksi, kecermatan seleksi, karakteristik produksi, itik Magelang

ABSTRACT

This research was aimed to estimate selection response and accuracy of hatching weight, growth and egg production using different selection intensities in Magelang duck. A nested design was used in this study with experimental material was Magelang duck consisted of 8 male (treatments), 40 female (sub-treatments) and 360 offspring (replicates) and the observed parameter was productive characteristics. Nine DOD from each female were measured for hatching weight and growth up to 8 weeks old. The measured Hen Day Production (HDP) at initial laying for within days. Result showed that different selection intensities (25, 50 and 75%) led to response in 2.968; 1.870 and 0.982 g hatching weight; respectively; 0.00221, 0.00139 and 0.00073 g growth, respectively; and 1.728, 1.088 and 0.571% egg production, respectively. Selection accuracy for hatching weight, growth and egg production was 0.70, 0.76 and 0.51, respectively. Conclusively, the less preserved female proportion, the higher selection intensity value thus the higher selection response. Selection accuracy of production

characteristics was based on its heritability value.

Keywords: selection responses, selection intensity, selection productivity, production characteristics, Magelang duck

INTRODUCTION

In some Asian countries like China (Pingel, 2009), Vietnam (Dat *et al*., 2008 and Cheng *et al*., 2009), Bangladesh (Hossain *et al*., 2005), Cambodia (Dinesh *et al*., 2009), Thailand (Tokrishna *et al*., 2009) and Indonesia (Pangemanan *et al.,* 2014), duck is a prominent commodity specifically in cattle farming and economic agriculture in general (Adzitey and Adzitey, 2011). Duck farming in Indonesia has become government's concern to raise the population and production performance as the increased demand of animal protein in form of meat, egg and milk. The aim was to increase duck population in 2010-2014 from 37,950,686 to 43,902,389, meat production from 28,554 to 33,032 ton, and egg production from 1,506,836 to 1,791,609 ton. The accomplished target of increased quality and quantity was by optimizing the existing local resources (Directorate General Ministry of Agriculture and Animal Health, 2011). Magelang duck is local duck mainly bred and developed in Magelang and the surrounding area with 200-600 meter above sea level (masl) altitude or located in cool upland. Government has declared Magelang duck as Magelang duck family in Decree of Minister of Agriculture 70/kpts/PD.410/2/2013 (Department of Farming and Fishery (Peterikan) of Magelang Regency, Central Java, 2013). High body immune that enables duck to accommodate different temperate areas makes Magelang duck preferred among duck growers. Magelang duck body shape is generally wider and bulky than other local duck. Purwantini *et al*. (2015) reported that Magelang duck has higher body weight during initial production than Tegal duck, 1,612.18 ± 122.74 g and 1,392.74 ± 117.99 g, respectively. Magelang ducks also have more varied plume colors, 11 as reported (Purwantini *et al*. 2013).

Duck breeding is important conducted in Indonesia to improve the duck's genetic quality for future genetic or germ plasm resources of local duck in Indonesia. Improving quantity and quality of the offspring is basically through genetic improvement by selecting the best male and female from the group then conducting purposive mating or crossbreeding to produce more excellent offspring than the parents (Lin *et al*., 2014). The selected characters are following economic concern, namely weight, egg amount, color and index, fertility, hatching weight and hatchability (Sari *et al.,* 2011). The objective of selection is to increase the desired gene frequency in population and to decrease the unwanted gene frequency (Addisu *et al*., 2013)

Selection is based on high phenotypic value and breeding value (Falconer, 1983). Improving genetic quality is by estimating breeding value affected by heritability value (h^2) and the difference between the mean of selected parents with the average population of the generation (Warwick *et al*., 1995). Selection success is observed from the improved production particularly the responses and selection accuracy. Selection responses (R) is the improving ducks' genetic, often symbolized as ΔG where change (Δ) occurred in genetic value (G). selection responses and accuracy depend on selection intensity, genetic structure within population, and selection environment (Reddy, 1996). Selection intensity is the deferential selection stated in standard deviation (Hardjosubroto, 1994), therefore the value relies on the available amount if individuals as population for selection and variation.

Hatching weight, growth and egg production are quantitative expression that occur according to genetic and environmental factor. The productive characteristics may serve as the important selection criteria for superior genetic duck considering duck's high contribution to meet nutrition need in society particularly national meat and egg production. Growth rate and increasing egg production are conducted by selecting individuals with growth rate and egg production above average.

To date, only few publications are made on responses estimation and selection accuracy of productive characteristics with different selection intensity in Magelang duck, therefore this research is aimed to investigate the existing selection success. In accordance with government program to optimize the available local resources by improving the quantity and quality, a research was conducted to estimate the responses and selection accuracy of hatching weight and growth using different selection intensity in Magelang duck.

MATERIALS AND METHOD

Research assigned 408 Magelang duck comprising 8 males, 40 females and 360 offspring to record the lineage, hatching weight, body weight up to 8 weeks old and daily egg production. The observed ducks were kept under similar maintenance. Composition and nutrient content for starter feed to grower are presented in Table 1.

Starter feed was given measuredly ad-libitum, while in grower the four-week-old ducks was given 100 g feed then increased to 150 g at eight weeks old. In production phase, feed was given 160 g/duck/day and water was provided ad libitum. Biyatmoko (2014) reported that estimated energy requirements (ME) and crude protein (CP) of Alabio layer ducks at 7 months old was based on measurements on feed consumption, average weight gain (AWG), body weight (BW) and egg weight. Metabolizable energy (ME) requirement on production phase of Alabio layer duck was 2652,43 kcal kg and crude protein was 19.47%. The crude protein content in this study was higher than the recommended 18% NRC (2004).

A nested design was used for the experimental method where male duck was variable, female was sub-variable, offspring was replicates and productive characteristics as the observed variables (Becker, 1992). Female was randomly mated with male within population. Nine DOD from each mother was measured for hatching weight and growth for 8 weeks. Hen Day Production was measured at early hatching for 90 days, and the amount of egg based on individual production record was divided by total days and multiplied by 100 percent (Ahmad *et al*., 2010).

Statistical model was as follows:

$$Y_{ijk} = \mu + P_i + I(P_i)_j + E_{ijk} \text{ (Becker, 1992)}$$

Y_{ijk} = the k result of production characteristics measurement from the j female to the i male

μ = mean of population

P_i = effect from the i male

$I(P_i)_j$ = effect from the j female on the i male

E_{ijk} = random effect or measure error on the k production characteristic from the j female to the i male

Relative growth rate calculation was following Brody (1945) in Arifah *et al*. (2013):

$$LPR = \frac{(w_2 - w_1)/(t_2 - t_1)}{\frac{1}{2}(w_2 + w_1)}$$

where :

LPR = Relative Growth Rate

w_1 = hatching weight

w_2 = 8-week-old body weight

t_1 = time gain w1

t_2 = time gain of w2

Heritability value of hatching weight and growth, 0.49 ± 0.073 and 0.58 ± 0.032, respectively, was according to Purwantini *et al*. (2014). Heretability value of egg production obtained from analysis of variance on male and female variable was 0.27 ± 0.035.

Performance test in selection was performed to test the individual producibility under equal breeding maintenance. Duck's individual producibility compared to individual BV estimated from one production record using path coefficient diagram (Figure 1)

Individual Breeding value (BV):

$$BV = h^2(P - \bar{P})$$

where:

h^2 = heritability of production characteristics

P = individual production characteristics

$\bar{P}$ = mean of population production characteristics

Each individual's BV was estimated and ranked to determine the selected and the eliminated ones from the population. Estimated selection responses was obtained before the selected individual was determined, but the proportion or selection intensity from the individuals preserved in population. Selection responses was calculated according to Warwick *et al*. (1995) and Hardjosubroto (1994).

Selection responses value per generation is following the equation:

$$R = h^2 . i . \sigma_P$$

where :

R = selection responses per generation

h^2 = heritability value of characteristics

i = selection intensity

σ_P = standard deviation of individual characteristics within population

The remaining female proportion was 25, 50 and 75% of population or 10, 20 and 30 ducks respectively.

Selection accuracy for one production record = $\sqrt{h^2}$

Table 1. Composition and Nutrient Content for Starter feed to Grower and Layer

Feed	Starter Feed	Grower Feed	Layer Feed
Corn	BR 1	47.0	35.0
Fishmeal		8.0	10.0
Rice bran		37.0	45.0
Meat bone meal		5.0	7.0
Milled corn cobs		2.0	2.0
Premix		1.0	1.0
Total		100	100
Feed nutrient content:			
Crude protein (%)	21	15.068	16.95
ME (kcal/kg)	3000	2806.425	2.844
Crude fiber (%)	5	7.042	7.86
Crude fat (%)	5	4.322	8.07
Ca (%)	1	1.805	0.56
P (%)	0.9	1.221	0.97

Source: Calculation based on NRC (2004) and proximate (2015)

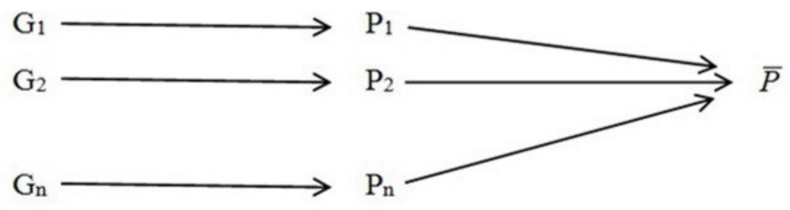

Figure 1. Path coefficient diagram. G_1 = The 1st individual; G_n = The n individual (n = 1, 2, ...n), P_1 = The 1st individual production characteristics; P_n = The n individual production characteristics (n = 1, 2, ...n); $\overline{P}$ = mean of population production characteristics

RESULTS AND DISCUSSION

Production Performance of Magelang Duck

Mean and standard deviation of egg weight, hatching weight, growth up to 8 weeks old, and egg production of Magelang duck are presented in Table 2.

According to Onbasilar *et al*. (2011) some contributing factor to production characteristics were environment, genetic, nutrition and production cycle. Further, egg weight and quality were attributed to age and production cycle. Table 2 shows that the obtained hatching weight was higher than 36.37 ± 3.89 g of 65.32 ± 3.81 g egg weight of South Sumatran Pegagan duck (Sari *et al*., 2011) and relatively smaller than 70.84 ± 7.82 g of Chinese native duck (Xue *et al*., 2013). Mojosari duck’s egg weight was 60.83 g (Yulianti *et al*. 2015). Dewanti *et al*. (2014) reported that mean hatching weight of local duck was 38.59 to 46.44 g from 53 - 60 g and 69 -76 g egg weight, respectively, and Magelang duck was 41.7 ± 3.09

Table 2. Mean and Standard Deviation of Egg Weight, Hatching Weight, Growth up to 8 Weeks Old, and Egg Production of Magelang Duck

Characteristics	Mean and Standard Deviation
Egg weight (g)	65.34 ± 4.89
Hatching weight (g)	43.07 ± 4.77
8 week old weight (g)	1277.10 ± 164.76
Growth (g)	0.234 ± 0.003
Egg production (%)	58.69 ± 5.04

g (Lestari *et al*., 2013). Body weight of 4 and 10 week old male local duck was 349.68 ± 46.92 g and 1021.23 ± 45.50 g, respectively, with 0.17 ± 0.013 relative growth (Arifah *et al*., 2013). Mean and standard deviation of hatching weight, 8-week-old weight and relative growth of Magelang duck was 47.34 ± 2.29 g; 876.70 ± 43.28 g and 0.22 ± 0.007, respectively.

Several research on the egg production of native duck and the crossbred in Indonesia have been reported. Annual production of crossbred Mojosari-Alabio (MA) ducks was 69.4%, the herded ducks was only 26.9 - 41.3%, and the confined ducks was 55.6% (Ketaren dan Prasetyo, 2000). Egg production of molting crossbred Alabio-Pekin (AP) and Pekin-Alabio (PA) was 52.36 - 71.13% and 60.21 - 79.47%, respectively (Susanti *et al*., 2012), while in Philippine mallard duck with black, brown, dark brown and light brown plume was 83.96, 76.68, 77.51 and 74.76%, respectively (Datuin and Magpantay, 2013). Different result was assumedly due to different species, population size, time and venue of measurement.

In this research, environmental factors (V_E) were equal feed, breeding and maintenance. The uncontrollable environmental factors, sex and the male had no significant effective; therefore, the phenotypic characteristics, hatching weight, growth and egg production of Magelang duck showed genetic variation ($V_P = V_G$). Analysis of variance result showed that female significantly affected hatching weight, growth and egg production in Magelang duck, therefore effective selection was expected to conduct on female.

Selection Responses of Magelang Duck

Selection was performed by production test method or individual record upon comparing individual production (female) based on BV of individual hatching weight, growth and egg production estimated from one production record. Hardjosubroto (1994) claimed that individual selection was based on individual production record that was important to trace the characteristics measured in both sexes pre-adult or on the first pre-mating.

The chosen or preserved female for the next generation was based on selection criteria or characteristics and proportion or selection intensity applied. The rank of Magelang duck based on BV of hatching weight, growth and egg production are presented in Table 3.

Table 3. shows that individual rank was based on characteristics BV, and therefore different across individuals and characteristics. Accordingly, the chosen or preserved individuals for the next generation depended on the applied characteristics.

The increased selection result on the next offspring was indicated from the extent of selection responses. Selection responses was determined by heritability (h^2), selection intensity (i) and standard deviation of population (σ_P). Hatching weight h^2 (h^2_{BT}), growth (h^2_{PBBH}), and egg production h^2_P was 0.49; 0.58 and 0.27, respectively, while selection intensity was determined by the preserved female proportion (%). Population standard deviation of hatching weight (σ_{PBT}), growth (σ_{PPBBH}) and egg production (σ_{PP}) 4.77 g, 0.003 g and 5.04 %, respectively.

Assigning equal h^2 value and standard deviation and different selection intensity resulted in different selection responses. Result based on selection estimation is presented in Table 4. Table 4 shows that the less preserved female proportion, the more selection intensity and naturally the selection responses. The preserved female proportion was 25, 50 and 75%, so the selected female was rank No 1 to 10, 1 to 20 and 1 to 30. Accordingly, selection responses would improve by lowering the preserved female proportion. This research was the initial stage on selecting female duck to be the ascendant to produce excellent offspring that will be the next ascendant.

Selection Accuracy of Magelang Duck

Selection accuracy or the level of correlation between selection basic criteria and individual BV

Table 3. Rank of Magelang Duck based on Breeding Value of Hatching Weight, Growth and Egg Production

Rank	Female TAG	Hatching Weight NP	Female TAG	Growth NP	Female TAG	Egg Production NP
1	M4.4	2.5676	M4.3	0.001839448	M8.4	9.6537
2	M8.3	2.5676	M3.4	0.001831748	M4.4	9.0537
3	M1.5	2.0776	M4.2	0.001803933	M1.3	7.5537
4	M3.1	1.0976	M2.3	0.001712266	M6.2	6.9537
5	M6.4	1.0976	M5.3	0.001672234	M1.2	6.3537
6	M7.1	1.0976	M7.2	0.001554567	M2.1	6.3537
7	M7.3	1.0976	M3.3	0.001437301	M4.1	6.3537
8	M8.1	1.0976	M3.5	0.001370888	M8.1	6.0537
9	M6.3	0.6076	M7.4	0.001328924	M2.2	5.4537
10	M6.5	0.6076	M8.3	0.001284847	M4.2	5.1537
11	M1.1	0.1176	M6.4	0.001227024	M1.5	3.6537
12	M4.5	0.1176	M1.1	0.001099747	M5.3	3.0537
13	M5.1	0.1176	M1.3	0.00109275	M2.5	2.7537
14	M5.4	0.1176	M7.5	0.001062624	M1.4	2.1537
15	M6.2	0.1176	M1.2	0.000975631	M3.5	1.8537
16	M8.5	0.1176	M8.2	0.000845597	M4.5	1.8537
17	M1.4	-0.3724	M2.2	0.000767985	M5.5	1.8537
18	M2.1	-0.3724	M3.1	0.000617181	M7.2	1.5537
19	M2.5	-0.3724	M2.4	0.000615094	M7.5	1.5537
20	M3.2	-0.3724	M6.1	0.000549998	M2.4	1.2537
21	M3.3	-0.3724	M5.1	0.000336637	M1.1	0.9537
22	M4.1	-0.3724	M1.4	0.000297705	M7.4	0.3537
23	M7.2	-0.3724	M5.2	0.000294167	M8.3	0.3537
24	M3.4	-0.8624	M8.4	0.00020622	M3.3	-0.5463
25	M1.2	-1.3524	M4.1	0.000103775	M2.3	-0.8463
26	M6.1	-1.3524	M6.3	4.24886E-05	M5.1	-1.7463
27	M7.4	-1.3524	M2.1	4.18441E-05	M8.5	-1.7463
28	M2.3	-1.8424	M8.1	1.03998E-05	M3.4	-2.0463
29	M2.4	-1.8424	M1.5	-1.88063E-05	M7.1	-2.0463
30	M4.3	-1.8424	M8.5	-0.000123095	M6.5	-2.3463
31	M5.3	-1.8424	M5.4	-0.000130112	M8.2	-2.9463
32	M5.5	-1.8424	M7.3	-0.000271077	M5.2	-3.2463
33	M1.3	-2.3324	M3.2	-0.00033333	M6.1	-3.2463
34	M2.2	-2.3324	M2.5	-0.000432021	M7.3	-3.2463
35	M3.5	-2.3324	M6.2	-0.000487498	M4.3	-3.8463
36	M4.2	-2.3324	M4.4	-0.000694635	M6.3	-3.8463
37	M5.2	-2.3324	M5.5	-0.0007741	M3.2	-4.1463
38	M8.4	-2.3324	M6.5	-0.001264834	M3.1	-4.4463
39	M8.2	-2.8224	M4.5	-0.001345738	M6.4	-5.0463
40	M7.5	-3.3124	M7.1	-0.001958209	M5.4	-5.3463

BV = Breeding Value

Tabel 4. Estimated Selection Responses with Different Selection Intensity on Hatching Weight, Growth and Egg Production of Magelang Duck

Preserved Female Proportion (%)	Preserved Female Rank	Selection Intensity (i)	Selection Responses on Characteristics		
			Hatching Weight (g)	Growth (g)	Egg Production (%)
			(h^2_{BT} . i . σ_{PBT})	(h^2_{PBBH} . i . σ_{PPBBH})	(h^2_{P} . i . σ_{PP})
25	1 - 10	1.27	2.968	0.00221	1.728
50	1 - 20	0.80	1.870	0.00139	1.088
75	1 - 30	0.42	0.982	0.00073	0.571

h^2_{BT} = hatching weight heritability; σ_{PBT} = standard deviation oh hatching weight; h^2_{PBBH} = growth heritability; σ_{PPBBH} = standard deviation of growth; h^2_P = egg production heritability; σ_{PP} = standard deviation of egg production; i = selection intensity

of the selected characteristics for one production record was stated in formula $\sqrt{h^2}$. This value is important in breeding ducks because the higher accuracy value the higher expected responses. Selection accuracy value higher than 55% belongs to high category (Warwick *et al*., 1995). Accuracy value of hatching weight, growth and egg production of Magelang duck was 0.70; 0.76 and 0.51 and included in medium to high category. Accordingly, hatching weight, growth and egg production of Magelang duck were effective for selection.

CONCLUSION

The more mother proportion preserved, the higher selection intensity so the selection responses or result is bigger. Different productive characteristics show different selection accuracy based on heritability value. Hatching weight and growth are considered as selection criteria in breeding of Magelang duck.

ACKNOWLEDGEMENT

Sincerest gratitude goes to Directorate General of Higher Education, Ministry of Research, Technology and Higher Education through Research Centre and Community Service Jenderal Soedirman University for funding the Competitive Grant and contract no. 1135/UN23.14/PN.01.00/2015

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