Turkish Journal of Agriculture - Food Science and Technology, 6(10): 1311-1316, 2018

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X
www.agrifoodscience.com,
Turkish Science and Technology

The Relationships Between Egg Production, Age and The Hatching Traits of Pheasants[#]

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A R T I C L E I N F O

[#]*This study was the first author's master thesis.*

Research Article

Received 20 December 2017
Accepted 06 June 2018

Keywords:
Pheasant
Egg production
Age
Hatching traits
Embryonic mortality

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A B S T R A C T

Pheasant rearing is rated in three main categories: show and hobby, public interest, and stocking for game birds and edible purposes. The goal of this pheasant breeding station is to put stocking for game birds in their natural habitat, mainly in the Karadeniz region. Contribution to the issues related to incubation in this station and determination of effective reproduction age by setting production period. The aim of this study is to determine how significant performance criteria like egg production, fertility, hatchability and embryonic mortality are, depending on age and on seasonal changes. Our research has been carried out at the Gelemen Pheasant Breeding Station in Samsun. The pheasant breeds that are used on the farm are made up of 114 male and 800 female pheasants (1♂:7♀), of Hungarian and Caucasian genotypes. During the egg-laying period, which lasts for 16 weeks from the end of March (at the age of 45 weeks) to the middle of July (at the age of 60 weeks), egg production was recorded daily and evaluated once a week, and incubation yield was recorded nine times in total. Differences between weeks of age, in terms of egg production, egg and chick weights, fertility rate, incubation yield and embryonic mortality, have been found to be statistically significant. However, hatchability has been found to be statistically insignificant.

DOI: https://doi.org/10.24925/turjaf.v6i10.1311-1316.1765

Introduction

In recent years, interest in breeding and alternative poultry has become common because of a desire to be closer to nature. In particular, owing to an interest in birds that can be used in hunting, some growers have found breeding pheasant species to be a profitable venture. These initiatives were launched at a low level, enabling the creation of high-capacity pheasant breeding farms that grew over time (Yamak, 2015). Breeding game birds is rated in three main categories: show and hobby, public interest, and stocking for game birds and edible purposes (Scheid, 1986). Common pheasant varieties are produced for their meat and for hunting; because of this, they differ from other species. Jungle fowls, which are the ancestors of the chicken, are also members of the Phasianidae family. Their easy adaptation to various breeding conditions is a basic trait and they are produced all around the world (Scheid, 1986; Ucar et al., 2012). Pheasants are valuable for being a ground game animal for hunters and for their protein-rich meat and eggs. Also, because of the attractive appearance of their colors and feathers, different species are reared apart from their natural environment as a hobby or for sport. Pheasants arrived in Europe more than 1000 years ago from China, Japan and Anatolia (Long, 1981). In Kansas and also in Minnesota USA, about 100,000 to 150,000 hunters hunt 400,000 to 800,000 pheasants per season; this amounts to approximately 350,000 birds in a season (Llanas, 2014). Pheasants are useful creatures for humanity worldwide. By producing and managing pheasants, sustainable profit can be obtained with the help of economic inducements (Fuller and Garson, 2000).

Common pheasants are members of the family of Asian pheasants. In this species, which is polygamic every male has its own harem that contains 1 to 8 female(s) (Briganti et al., 1999). So while breeding, the male to female ratio must be kept at 1: 5, 1: 6 or 1: 7 according to the type being reared. In some pheasant species this ratio is 1: 8. Keeping breeding males and females seperate reduces the possibility of fighting (Cetin and Kirikci, 2000). Wild pheasants lay approximately 10 eggs for every 1 to 2 laying periods over a year (Sarica et al., 2003). The natural laying season that begins in spring, may be extended into winter by using artificial lighting. Thus, eggs can be obtained from the pheasants in every season of the year (Cetin and Kirikci, 2000), but, because of the male pheasants' readiness to mate only at certain periods of the year, the female pheasants can be artificially inseminated with 0.05 ml of diluted semen applied twice a week (Sarica et al., 2003). Most of the eggs produced from the pheasants are green and brown; a few of them can be beige or blue. Owing to their poorer incubation performance, beige and blue eggs should be used as eggs for the table. But, this doesn't mean a huge production for general table pheasant egg consumption (Kirikci, 2012). There are many factors that affect hatchability. When producing pheasants, the most important factors affecting profitability are the pheasants breeding ability and hatchery performance, which means the number of chicks obtained from the eggs of a healthy female (Krystianiak et al., 2007). According to the age and seasonal changes, there have been some problems with pheasants with regard to egg productivity and hatchability.

This study investigated problems arising during incubation (fertility rate, hatchability, embryonic mortality, etc.), during the egg production in a laying period and their relationship to the ages of the pheasants. The results were evaluated to make suggestions for the current systems in use.

Materials and Methods

Nutrition

The feed material ingredients shown in Table 1, were used to feed the birds during their chick and hen periods. During the study, water and feed was given as ad libitum to all pheasants.

Production System and Housing Conditions

The study was conducted at the Gelemen Pheasant Breeding Station of the Ministry of Forestry and Water Affairs in Samsun between March and July 2013 during the 16-week laying period. The incubation process was carried out in a 66 m^2 hatchery with 3 setter and 2 hatcher machines (Cimuka T-series), each one with a 2880 pheasant egg capacity. The breeders are placed on an 20 m^2 each and made entirely of wire, in a ratio of 1 ♂: 7 ♀ to the open breeding pens.

Animal Material

Hungarian (Ringed) and Local (Caucasian) genotype pheasants, bred using a mating ratio of 1♂:7♀ – the first hatched in May in 2012 – were used for the study. Because of deaths, the female pheasant numbers decreased to 780 by the end. The first eggs were layed at the end of March 2013. Before the laying period no lighting procedure was applied so that the first eggs started to be produced at the age of 45 weeks and the laying process continued until the second week of July. By this time, egg production had decreased and the breed flock was transferred to a conservation area for subsequent release.

Eggs and Incubation

Eggs were collected from the breeding pens twice a day (in the morning and in the afternoon) and hatched eggs loaded onto trays. Egg numbers were recorded daily. Eggs that were obtained from these breeds at 46 weeks were put into incubators every week, and 2880 eggs were put into each incubator. In the first 21 days of the incubation process, eggs were turned every 2 hours and kept at 37.7°C and 62% relative humidity. In the last 3 to 4 days of incubation, the heat was set to 37.7°C and the humidty was set from 85 to 90%, but the eggs were not turned. All eggs were individually weighed from 49 weeks to determine the best eggs for incubation. In the trial, the incubation processes were performed 9 times up to the age of 54 weeks. From each batch, 150 to 200 chicks were randomly selected and their weights determined. Unhatched eggs were broken and classified to determine the stage of embryonic mortality (early, mid, late or pipped). With the help of these data, standard fertility rates, hatchability and embryonic mortality rates were identified along with early, mid, late and pipped embryo death rates. The parents weights were determined by a weighing process choosing male and female (20♂ to 80♀) animals randomly, which were at the end of their breeding periods of 60 weeks.

Statistical Analysis

During the hatching studies, Chi-square analysis was applied to test the differences among parent ages – shown as percentages. Analyses were carried out on data primarily defined in percentage terms and using a non-parametric option. Significant tests were carried out within $P<0.05$ confidence limits on the binary predicates. The Chi-square test values were calculated automatically so that there wasn't a specific limit. Values for the embryonic deaths were expected to be below 5%; that's why Chi-square values were calculated using Fisher's Exact test, and the binary predicates were also derived according to Fisher's Exact test (Duzgunes et al., 1987; Ozdamar, 2002).

One-way variance analysis was performed to determine the weekly differences between the egg weights and chick weights. When comparing averages, the Duncan test was performed. SPSS analysis software (Version 20) was used in all comparisons by considering a 5% confidence limit.

Table 1 Feed – material ingredients of the feeds which were given to breed pheasants on different periods.

Feed	Usage Period		
	Chick (0-8 Weeks)	Poult (9-40 Weeks)	Laying (41-60 Weeks)
Crude Protein (%)	19	14.5	16
Crude Cellulose (%)	6	6	7
Crude Ash (%)	8	8	13
Calcium (%)	0.8-1.2	1.0-1.5	3.5-4.0
Phosphorus %)	0.5	0.40	0.33
Lysine (%)	0.9	0.65	0.75
Methionine (%)	0.4	0.33	0.47
Metabolic Energy (ME Kcal/kg)	2800	2750	2750

Results and Discussion

Female breeding pheasants started egg production at 45 weeks of age at a hatching level of 6.17%. Peak production was reached at 49 weeks with 72.07%. The egg production, which started to decrease in later periods, declined to 5.30% at 60 weeks old (Table 2). The mean hatching egg weight was found to be 32.27 g from eggs produced during the laying period and where weekly weight differences were considered to be significant ($P<0.05$). The heaviest egg was produced at 52 weeks old age, and weekly weights were from 31.78 to 32.82 g. The differences obtained in terms of the weights of the chicks during the incubation period were found to be significant ($P<0.05$) with the highest chick weight determined at the 48th week to be 22.54 g. For the 9 incubations, the average chick weight was calculated to be 21.27 g (Table 2).

Egg production of pheasants differs according to genotype and rearing applications. Sarica et al. (2003) noticed that with the help of heterosis it is possible to get 170 eggs in a year, and 150 of them could be used for hatching. In the flock that was used in our study, breeding and production was not carried out in accordance with natural conditions, and although it is not possible to express the actual performance, during the egg-laying production period, figures of 45.36% and an average count of 50.53 was obtained (Table 2). Our study started seasonally in the last week of March, which is the beginning of the laying period for pheasants, and these findings were noticed by others (Gibes et al.,1974; Wise, 1995). It was also noticed, based on temperature and periods of light – especially in their natural environment where breeding takes place – the laying period can be started in April or in the weeks after (Krystianiak et al., 2007; Aktas, 2009). Even though the age at the onset of laying is specified as 35 to 40 weeks in published literature, the first eggs obtained from the pheasants were in their 45th week. With an appropriate lighting schedule, it was possible for female pheasants to lay at an earlier age, and their laying period can be extended up to 27 weeks (Mashally et al., 1983).

Kuzniacka et al. (2005) noticed that the laying period lasts for 103 days (15 weeks). Krystianiak et al. (2007) noticed that the earliest laying age was 282.6 days, that the 1-year-old females' laying period was 109.3 days – which is 21 days longer than 2-year-old females – and the 1-year-old females started laying between 3rd to the 16th April, whereas 2-year-old females started laying between the 1st to the 24th of April. For pheasants bred in extensive systems, the egg production was noted to be 40 to 45%, and the egg count per female pheasant was calculated to be 65 (Yannakopoulos, 1992; Yilmaz, 2004).

There are some studies that noticed peak egg production in the 3rd week (Tserveni-Gousi and Yannakopoulos,1990), 4th week (Krystianiak et al., 2007), 6th week (Kuzniacka et al., 2005) and 7th week (Gibes et al., 1974). But some researchers' results showed peak egg production in the 5th week (Woodard and Snyder 1978; Usturoi 2008) following a rapid increase after the laying period started, that parallels our study. While Ustuori (2008) reaches peak egg production of 77.87%, Kuzniacka et al. (2005) reaches a value as high as 90.49%. While Kuzniacka et al. (2005) obtained an initial egg production of 7% and last week efficiency of 2%, Ustuori (2008) calculated higher figures with initial egg production at 2.84% and last week production at 12.31%. Pfaff et al. (1990) noticed egg production at a high value of 70% among the pheasants bred in open cages with rates of 1♂:19♀. Usturoi (2008) recorded less egg production than this study at 44.35%; Esen et al. (2010) noticed higher egg production in 1- and 2-year-old pheasants in the order of 47.58% and 53.27%, but at 42.69% for 3-year-old female pheasants.

Table 2 Egg production, egg weight and mean chick weight according to different laying ages

Laying Period (week)	Laying age (week)	Egg production			Egg weight (g) $\bar{x} \pm S\bar{x}$	Chick weight (g) $\bar{x} \pm S\bar{x}$
		Eggs / Bird / Week	Eggs / Bird / Cumulative	% (per week)		
1	45	0.42	0.42	6.17 ^{g}	31.78 ± 2.85 ^{c}	
2	46	3.56	3.98	51.16 ^{bc}	31.85 ± 2.90 ^{c}	21.85 ± 1.91 ^{b}
3	47	4.51	8.49	64.57 ^{ab}	32.10 ± 2.48 ^{bc}	20.73 ± 1.97 ^{d}
4	48	4.94	13.43	70.73 ^{ab}	32.29 ± 2.61 ^{abc}	22.54 ± 3.49 ^{a}
5	49	5.04	18.47	72.07 ^{a}	32.35 ± 2.32 ^{abc}	20.86 ± 1.62 ^{cd}
6	50	4.94	23.41	70.88 ^{ab}	32.54 ± 2.34 ^{ab}	21.45 ± 2.12 ^{bc}
7	51	4.56	27.97	65.47 ^{ab}	32.28 ± 2.45 ^{abc}	20.75 ± 2.08 ^{d}
8	52	4.57	32.54	65.49 ^{ab}	32.82 ± 2.68 ^{a}	20.98 ± 1.89 ^{cd}
9	53	4.33	36.87	62.06 ^{ab}	32.17 ± 2.46 ^{bc}	21.18 ± 2.05 ^{cd}
10	54	3.67	40.54	52.55 ^{ab}	32.34 ± 2.26 ^{abc}	21.09 ± 1.89 ^{cd}
11	55	2.91	43.45	41.79 ^{cd}	32.22 ± 2.30 ^{abc}	
12	56	2.32	45.77	33.57 ^{cde}	32.52 ± 2.45 ^{ab}	
13	57	1.94	47.71	27.97 ^{de}		
14	58	1.55	49.26	22.66 ^{ef}		
15	59	0.92	50.18	13.33 ^{fg}		
16	60	0.35	50.53	5.30 ^{g}		
	Mean	3.16	-	45.36	32.27 ± 2.52	21.27 ± 2.24

a,b,c: Differences among the egg efficiencies are shown by different letters according to the results of Chi-square analyses and the Duncan test results which are shown with different letters are significant ($P<0.05$).

Table 3 Fertility, hatchability of fertile eggs and hatchability rates according to laying age (%)

Incubation Period	Laying Age (weeks)	Fertility Rate	Hatchability of Fertile Eggs	Hatchability of Total Eggs
1	46	84.48 [a]	80.49	68.00 [a]
2	47	80.49 [a]	86.36	69.51 [a]
3	48	85.41 [a]	81.12	69.28 [a]
4	49	81.95 [a]	83.72	68.60 [a]
5	50	82.23 [a]	90.06	74.06 [a]
6	51	79.97 [a]	86.51	69.18 [a]
7	52	77.32 [a]	88.02	68.05 [a]
8	53	74.02 [a]	82.32	60.94 [a]
9	54	36.55 [b]	84.91	31.03 [b]
	Mean	75.82	84.83	64.30

a,b,c: According to the Duncan test results, the differences between egg production shown by different letters are remarkable.

Table 4 Embryonic mortality rates related to the laying ages (%)

Incubation Period	Breeder Age (week)	Age of mortality			
		Early	Middle	Late	Pipped
1	46	3.22	7.01	4.73	4.55
2	47	3.60	4.73	3.60	1.70
3	48	1.80	7.19	5.76	4.14
4	49	3.64	4.60	4.02	4.02
5	50	1.26	3.63	4.42	0.63
6	51	1.73	3.47	4.43	3.85
7	52	1.86	2.69	6.40	1.03
8	53	1.85	5.28	6.60	3.96
9	54	0.94	4.72	7.55	1.89
	Mean	2.21	4.81	5.28	2.86

Genc and Ozbey (2013) noted egg weight averages that were produced by 36 to 40, 41 to 44, 45 to 48 and 49 to 53 week-old pheasants to be 28,67, 30.08, 31.04 and 31,85 g, respectively. Similarly, Usturoi et al. (2010) obtained egg weights of the order of 28.64, 31.02, 31.87 and 32.16 g, which they collected during the laying period in weeks 1, 5, 8 and 13, and the average egg weight was 30.92 g; these results are lower than our study. The flocks that we used in our study started laying at an older age than usual – as recorded in published literature – and it is possible that caused a positive effect and heavier weights. But, Kuznizcka et al. (2005) remarked on variable egg weights and also noticed that as the weeks progressed, laying showed a downward trend as in our study. They measured the eggs in the laying period's 3rd, 5th, 7th, 9th, 11th and 13th weeks at 31.4, 31.0, 31.0, 31.8 and 30.7 g, and they reported the average egg weight to be 31.3 g. Although the examples given above were carried out for different feeding, rearing, housing and environmental conditions, it was seen that their average rates are lower than our study. Sarica and Karacay (1994) reported the daily chicks' weights to be 24.75 g. Cetin et al. (1997b) measured the chick weight to be 21.97 g, which they obtained from incubation breeding in an intensive system, and this result is higher than our study. Kuzniacka et al. (2005) though, reported the weights lower at 21.5, 20.7, 20.2, 20.3, 20.4 g and the average weight to be 20.7 g, the chicks – which they produced from eggs during laying periods in the 3rd, 5th, 7th, 9th and 11th weeks – paralleled our study.

All averaged results related to the hatchery operations, such as fertility rate, hatchability of fertile eggs and hatchability were measured to be 75.82, 84.83 and 64.30%, respectively. In this study, the highest fertility rate was found in 48-week-old eggs. After the 48th week the fertility rate decreased. Fertility rates in the hatchery measured from 36.55% to 85.4% ($P<0.05$). In the study, a significant decline occurred in the fertility rate in the last incubation, and accordingly, on the hatchability. The highest hatchability rate for fertile eggs gained were produced from 50-week-old birds at 90.06% (Table 3).

It is thought that the high fertility rates obtained in this study were related to the age of the breeding flock. Ipek and Yilmaz (2006) calculated fertility rates of 78.6 and 83.3% from the same flock which they bred at a rate of 1♂:8♀ and produced eggs taken in the 1st and 2nd laying periods; these results are higher than our study. Esen et al. (2010), remarked on the hatchability of fertile eggs which were produced at a rate of 1♂:4♀ by the pheasants – at ages 1, 2, and 3 – and found to be 67.13, 74.88 and 76.12%, respectively. Ipek and Yilmaz (2006) calculated the hatchability of fertile eggs, which they produced during the 1st and 2nd incubation period (1♂:8♀), to be 74.5 and 81.2%, respectively.

Cetin et al. (1997a) calculated the hatchability to be 62.03% during the hatching period, which produced pheasants at rate of 1♂:5♀. Deeming et al. (2011) noticed that pheasants breed at a rate of 1♂:7♀ in open systems and their hatchability was over 70% in the first 5 weeks of a 10-week period, then – similar to our study – the efficiency declined. Esen et al. (2010) calculated the hatchability in their 1-, 2- and 3-year old's, at rate of 1♂:4♀, to be 63.35, 69.68 and 71.45%, respectively. Ipek and Yilmaz (2006) noted the hatchability produced by the same 1♂:8♀ flock during their 1st and 2nd laying periods to be 58.6 and 67.6%, respectively. In reported studies, it is seen that the male: female ratio is not sufficient when based only on fertility. Deeming and Wadland (2002) reported that, for a breeding rate of 1♂:12♀, the fertility rate was found to be about 85%, and for a breeding rate of 1♂:4♀, the fertility rate changed from 57 to 75 % (Esen et al., 2010; Genc and Ozbey, 2013). It is seen that there is an increase in hatchability that reached its peak at the 6th week (5th incubation) of the breeding period. Subsequently, while the hatchability of fertile eggs maintained its rate at a certain level, parallel to the decrease in fertility rate, hatchability decreased to reach its lowest level in the last hatching period. Marzoni et al. (2000) obtained semen from the male pheasants that were between 40 to 56 weeks old and they split them into three groups according to the female pheasants' egg production levels (1 to 3 weeks, 4 to 11 weeks and 12 to 16 weeks) to evaluate the semen produced by its volume, concentration and viability. They noted that, in transitioning from the first period to the second period, there is a significant increase in the volume and concentration of semen, and there is a huge rise in the number of spermatozoa per ejaculation, whereas in the last period there is a significant decrease in sperm concentration. The decrease in fertility rate can be explained as a libido impairment after the 9th week of the laying period of the pheasants (especially in the male pheasants), which tend to breed seasonally.

The performance of the hatching process for the early, middle, late and pipped death rates were found to be 2.21, 4.81, 5.28 and 2.86%, respectively. Last-term embryo deaths (8.14%) were seen to be the highest death rate (Table 4). At the end of the breeding pheasants' laying period (60th week), the difference between male and female pheasant average body weight is significant (P<0.05). There is a variation in body weight among both the male and female pheasants. It is considered a significant factor that, among the breeding flock, nothing has been done to ensure uniformity (Table 5).

Table 5 Parent body weights at the end of the laying period (g)

Age (Week)	Gender	N	Min	Max	$\bar{x} \pm S\bar{x}$
60	Male	20	1240	1650	1414.5 ± 105.5^{a}
60	Female	80	730	1370	1030 ± 119.4^{b}
	Total/Mean	100	730	1650	1106.9 ± 193.4

a.b: According to the Duncan test results, the differences between egg production shown by different letters are remarkable. (P<0.05).

Deeming et al. (2011) reported early embryo death rates between 4.5 and 5%, and middle to late embryo death rates to be between 15 and 16% in total at the end of the incubation process, which lasted for 10 weeks with the pheasants they bred in an intensive system. Deeming and Wadland (2001) calculated the embryo deaths of the eggs that they produced from pheasants to be at a rate of 1♂:8♀ and 1♂:12♀, by dividing them into 6 groups on specific days (1 to 4, 5 to 8, 9 to 12, 13 to 16, 17 to 20 and 2 1 to 25). They calculated the death rates which occurred on these specific dates to be – in order – 5 to 6, 1 to 2, 1 to 2, 1, 1 to 2 and 14 to 16%. As revealed in the study, it was reported that when higher production was reached, embryo death rates were decreased and, as a result, there was an increase in hatchability (Elibol and Turkoglu, 2014).

Sarica et al. (2003) reported the male and female body weights of some subspecies: Chinese (1000 to 1300g) and American (910 to 1230g) – these weights are lower than our study; Mongolian (1500 to 2000g), Ringed (1320 to 1720g), American Hybrid (1140 to 1480g), Melanistic (1250 to 1620g) and Melanistic Hybrid (1270 to1710g) – these weights are higher than our study. It can be said that there is a huge variation among common pheasants regarding their body weights. Cetin et al. (1997a) calculated the body weights of the male and female, mixed Hungarian (Ringed) and Domestic (Caucasian) pheasants, which they used in their study, to be of the order of 1214 to 1430.8 g, although their age was 41 weeks: this rate is higher than our study. It can be said that the main reason why their average weight is higher than our study is because the Caucasin genotype was more abundant in our flock. Usturoi (2008) reported the male and female average body weights to be from 1317.24 to 931.12 g at the beginning of the 13-week laying period; at the 5th week – which is the peak – they were from 1339.68 to 983.28 g; whereas at the end of the laying period they were from 1435.35 to 1014.61 g. It is understood that if the average weight at the end of the laying period is taken into consideration, it is similar to our study.

Conclusion

As a result, for adequate breeding in terms of implemented production systems, light stimulation can be appropriate at the beginning of February if egg production is to be raised. In this way, between February and June, which is the natural production period, more eggs hatch on the farm. There is a need for further research that will present what the expected performance parameters are for the places that are breeding stock pheasants in their natural habitat and showing the adaptation and reproductive levels of pheasants released to the natural environment.

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