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HATCHING PERFORMANCE OF ARBOR ACRES BROILER BREEDER STRAIN AT FOUR PRODUCTION PHASES WITH THREE EGG WEIGHTS AND STORAGE PERIODS

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ABSTRACT

The present study was conducted to evaluate the hatching performance (average egg size, moisture loss, fertility, hatchability and hatch of fertile eggs) in Arbor Acre broiler breeder strain eggs during four production phases (pre-peak, 25-28; peak, 29-36; post-peak, 37-52 and terminal, 53-56th weeks of age), categorized into three egg weights (small, medium and large; changed in each production phase), maintained at three different storage periods (1, 4 and 7-days) and replicated 6 times. A total of 93312 fertile eggs (pre-peak: 11664, peak: 23328, post-peak: 46656 and terminal: 11664) in 4 production phases were subjected to hatching in a commercial hatchery. The data were analyzed using ANOVA technique under randomized complete block design in a 4×3×3 factorial arrangement and means were compared using DMR Test. Results showed significant ($p\leq0.05$) differences for average egg size and fertility percent in large egg weight category alone as well as its interaction with all three storage periods. Significantly ($p\leq0.05$) higher moisture loss was observed in large and small egg categories and highest in seven days storage alone and its interaction with all egg weight categories during post-peak. Regarding hatching traits, significantly ($P\leq0.05$) highest hatchability percent and hatch of fertile percent were observed in large egg weight category alone and in interaction between egg weight categories and storage periods during pre-peak and peak, while during post-peak and terminal phases medium egg weight category showed higher hatchability and hatch of fertile percent. Significantly ($p\leq0.05$) higher hatchability and hatch of fertile percent were observed in one and four day storage period. It is concluded from the present study that large egg weight category coupled with 1 or 4 day storage period had maximum fertility, hatchability and hatch of fertile percent in Arbor Acre broiler breeder strain.

Key words: Broiler breeder strain, egg size, fertility and hatchability percent, hatch of fertile, production phases.

INTRODUCTION

The modernization of incubation technology and genetic selection for improved growth performance has decreased the production cycle time in broiler chickens and the incubation process of 3 weeks has respectively become a larger part of the total chicken lifespan (Hulet, 2007). Due to growing global population, entire pressure to fulfill dietary needs is on the commercial broiler industry to produce more chicks and hence the meat. Commercial broiler is being raised with full genetic potential and nutritional control. Now, the major focus of broiler producers is to control the losses in poultry production chain. More number of chicks can be obtained by managing the hatching eggs and incubation parameters which are crucial to incubation and hatching process. Egg weight and its storage period are among the most critical post-ovipositional parameters affecting the embryonic development and hatching of day old chicks (Alsobayel *et al*., 2013; Abudabos *et al.,* 2017) as well as the subsequent performance (Sözcü and Ipek, 2017). Egg weight is related to egg weight loss due to water evaporation during incubation (Stępińska *et al.,* 2017). A positive relationship between egg weight loss and egg weight may result in decreased hatchability and higher early and late embryonic mortality (Alabi *et al*., 2012) whereas some studies showed inverse relationship between egg weight and egg weight loss (Abanikannda *et al.,* 2011). However, Abiola *et al.* (2008) were unable establish a particular trend for weight loss in varying egg sizes. Hatchiblity of incubated eggs was higher in heavy eggs than the light weight eggs (Prabkaran *et al.,* 1984; Senapati *et al.,* 1996). Asuquo and Okon (1993) observed that egg size within the intermediate range of 45-56 g would hatch better than small eggs. On the other hand, Proudfoot and Hulan (1981) found that the weight of egg had no effect on fertility and hatchability of fertile eggs. However, Abiola *et al.* (2008) reported that hatchability did not follow any particular trend with egg weight.

Although several other factors are involved in fluctuating the hatching traits, but the length of egg storage period before the incubation is of particular importance due to its influence on physio-chemical properties of egg (Alsobayel *et al*., 2013). In earlier studies, hatching performance of fresh and stored egg was found to be similar (Mather and Laughlin, 1976). Later on, Benton and Brake (1996) suggested that the low pH of fresh eggs might be detrimental to embryo survival and hatchability. Romao *et al.* (2008) found that weight loss during incubation was directly influenced by weight loss during the storage. Lower hatchability and hatch of fertile are the major outcomes of prolonged storage (Elibol *et al.,* 2002; Tona *et al.,* 2004). Inconsistent view point expressed by different scientists in respect of effects of egg weight and storage length on hatching profile suggests the need for comprehensive investigations. Objectives of present were to investigate the effect of different egg weight categories stored for three different durations on the hatching performance of Arbor Acre broiler breeder strain during four production phases.

MATERIALS AND METHODS

Experimental plan: The study involved egg collection during four production phases (pre-peak; 25-28, peak; 29-36, post-peak; 37-52 and terminal; 53-56th weeks of age) which were categorized into three different weight ranges (small, medium and large) and stored for three different periods (1, 4 and 7-days) and replicated six times. A total of 93312 fertile eggs in four production phases, pre-peak: 11664, peak: 23328, post-peak:46656 and terminal: 11664 eggs were collected from already maintained flock of Arbor Acre at a commercial farm. During each week of the experiment, a total number of 972 eggs per storage period from three egg weight categories replicated 6 times (each replicate containing 54 eggs) were used. After categorization according to weight, the eggs were according to experimental plan into three storage periods i.e 1, 4 and 7 days at in egg store room where temperature was maintained temperature 65 – 68°F and relative humidity level 75–80 %. Then the eggs were set in fully automatic multi-stage Chick-Master Setter machine with standard hatching conditions; temperature 99.5°F and 50% relative humidity and egg turning on hourly basis. The eggs were kept in the setter from 18–18.5 days and then were transferred to Chick-Master Hatcher machine at temperature 98.5°F and relative humidity 70 % for a period of 2.5–3 days. The hatching performance was assessed in terms of average egg weight, moisture loss (%), fertile egg (%), hatchability (%) and hatch of fertile (%) using following equations.

$$\text{Hatchability \%} = \frac{\text{No. of Chicks hatched}}{\text{Total No. of Eggs set}} \times 100$$

$$\text{Hatch of fertile\%} = \frac{\text{No. of Chicks hatched}}{\text{Total No. fertile Eggs}} \times 100$$

(Hussain, 2013)

Statistical analysis: The data thus collected were analyzed using analysis of variance (ANOVA) technique (Steel *et al.,* 1997) under Randomized Complete Block Design in a 4×3×3 factorial arrangement for further interpretation using general linear model (GLM) procedure (SAS 9.1, 2002-03) portable software. The mathematical model was assumed after Ishaq *et al.* (2014, 15). The comparison of means was done using Duncan's Multiple Range test procedure (Duncan, 1955).

RESULTS AND DISCUSSION

i. Average egg size (g): The results of the present study showed that the egg weight category had significant ($p \leq 0.05$) effect on egg size in broiler breeders during all production phases (Table 1).The highest egg size was observed in large egg weight category followed by that of medium and small ones. This could be attributed to egg categorization according to weight and increase in egg size with advancement of age. Similarly, Roque and Soares (1994) and Abiola *et al.* (2008) reported a positive correlation between flock age and egg size. The egg storage had non-significant ($p > 0.05$) effect on average egg size during all the production phases(Table 1) which could be attributed to negligible amount of moisture loss during storage (Becker *et al.,* 1968). Similar results were reported by Caglayan *et al*. (2010) and Demirel and Kirikci (2009), who found no significant effect of storage period on egg weight. As far as interaction between egg weight categories and storage period is concerned, maximum ($p \leq 0.05$) average egg size was observed in large egg weight category in all the three storage periods followed by that of medium and small egg categories in all the storage periods (Table 1).

ii. Moisture loss percent: Egg weight category showed non-significant ($p > 0.05$) differences in moisture loss during all production phases except post-peak during the entire experimental period (Table 2). This might be due to three different egg weight categories used having equal proportion of pore areas and pore diameter regardless of the size of egg (Abiola *et al.,* 2008). Significantly ($p > 0.05$) higher moisture loss was observed during post-peak in large and small egg categories than medium ones. This might be due to larger egg size used. It has been reported that heavier eggs had a greater proportion of albumen (Ulmer-Franco *et al.,* 2010), the major component of which is water (approximately 88% of the total weight) thus leading to higher moisture loss in larger eggs (Ahn *et al.,* 1997). Similarly, Alabi *et al.* (2012) reported increased loss of egg weight with increase in egg weight. However, higher moisture loss in small eggs was also not surprising because of the increased surface-to-volume ratio in small/light eggs (Ulmer-Franco *et al.,* 2010). Abanikannda *et al*. (2011) also reported an inverse relationship between egg weight and weight loss between egg setting and candling at 18th day. The storage period had significant (p≤0.05) effect on moisture loss during all production phases with highest moisture loss in seven days storage followed by four and one day storage (Table 2). This might be as a result of direct influence of egg weight loss during storage on weight loss during incubation; therefore, there might be higher moisture loss in eggs of seven days storage (Romao *et al.,* 2008). Seven days storage in interaction with all egg weight categories showed significantly (p≤0.05) the highest moisture loss, while, one day storage of large category showed the lowest moisture loss, suggesting a positive relationship between storage time and moisture loss.

iii. Fertility percent: Fertility percent was significantly (p≤0.05) influenced by egg weight category at post-peak and terminal stages but remained non-significant (p>0.05) during pre- and peak production phase (Table 3). The highest fertility percent was observed in large egg weight category followed by that of medium and small ones in all production phases except terminal phase. This might be due to sufficient amount of nutrients in large eggs to support embryonic growth compared to those of light weight eggs (Seker *et al.,* 2005). Similarly, Kingori (2011) explained that insufficient nutrients and lethal genes contributed in failure of a fertile egg to hatch. These results are in line with those of Mandlekar (1981). However, the highest fertility in small egg weight category followed by medium and large ones in terminal phase recorded in the present study might be due to higher moisture loss in large and medium eggs in this phase. Alabi *et al.,* (2012) reported increased egg weight loss with increase in egg weight. In the current study, storage period had non-significant (p>0.05) effect on fertility percent in all production phases. Eggs of larger weight category significantly (p≤0.05) interacted storage period especially at peak production phase showing 91.95±0.24 fertility%. During post-peak and terminal phases, significantly (p≤0.05) highest value was observed in medium egg weight category in all the storage periods. However, during pre-peak production, the medium eggs when stored for seven days exhibited lowest (65.75±2.47) fertility%. The lower fertility% in larger weight eggs during later stage of production rather than medium size egg can be attributed to lower quality of semen produced at older ages.

iv. Hatchability percent: Egg weight category significantly (p≤0.05) affected the hatchability percent in all production phases during the whole experimental period (Table 4). The highest hatchability percent was observed in large egg weight category followed by that of medium and small ones during pre-peak and peak. These results could be attributed to difference in egg size, as heavy eggs contained more sufficient nutritional substance to support embryonic growth compared to those of light weight eggs (Seker *et al.,* 2005). The findings of the present study are in close agreement with those of Altan *et al*. (1995) and Sachdev *et al*. (1985). Senapati *et al*. (1996) further indicated a positive correlation between egg weight and hatchability. In this study, medium egg weight category showed the highest hatchability percent followed by small and large ones in post-peak and terminal phases. This might be due to higher moisture loss in large and small egg categories during post-peak production. These results are in line with the findings of Asuquo and Okon (1993); Gonzalez *et al.* (1999) and Abiola *et al*. (2008), who recommended setting of average weight eggs in order to achieve good hatchability. Storage period significantly (p≤0.05) influenced hatchability percent during all production phases except in pre-peak phase in this study. Higher hatchability percent was observed in one and four day's storage periods than seven days. This might be due to effects of prolonged pre-incubation egg storage in terms of malformations and retarded growth of the early embryo leading to decreased hatchability (Sturkie, 1998). Similarly, Becker *et al*. (1968), Meijerhof (1992) and Reijrink *et al*. (2008) reported changes in embryo viability due to the negative effects of prolonged egg storage. Contrarily, Reijrink *et al*. (2010) reported increased hatchability due to prolong egg storage. Interaction between egg weight categories and storage period was found to be significant (p≤0.05) with higher values of hatchability percentage observed in large and medium egg weight categories in all the three storage periods in pre-peak and peak production phases. In the post-peak and terminal phases, significantly (p≤0.05) highest value was recorded in medium egg weight category in all the storage periods.

v. Hatch of fertile percent: Hatch of fertile percent was significantly (p≤0.05) affected by egg weight category in all production phases except post-peak during the course of this study (Table 5). Large egg weight category had the highest hatch of fertile % in pre-peak and peak production phases, which might be due to supply of sufficient essential nutrients which could have resulted in increased fertile hatchability. Similar results have been reported by Petek *et al.* (2003). However, medium egg weight category showed significantly (p≤0.05) higher hatch of fertile percent value than large and small ones in terminal phase. This might be due to higher moisture loss in large and small egg categories during terminal phase. The results of this study are in agreement with those of Asuquo and Okon (1993), Gonzalez *et al.* (1999) and Abiola *et al*. (2008), who suggested setting of eggs of average weight in order to achieve good hatchability. In this study, storage periods significantly ($p \leq 0.05$) affected the hatch of fertile percent during all production phases except in pre-peak phase. Higher hatch of fertile percent was observed in one and four day's storage period than seven days. This might be due to an increase in cell death during egg storage, which could have resulted in decline of embryo viability (Arora and Kosin, 1968; Bloom *et al.,* 1998). In addition, egg characteristics change due to loss of CO_2 and water from the egg. Albumen pH increases from about 7.6 to about 9.0 within 4 days of storage (Lapao *et al.,* 1999), which might be detrimental as Gillespie and Mc Hanwell, (1987) explained that a lower albumen pH may have a positive effect on embryo viability because the optimal pH for embryonic development is in the range of 7.9 to 8.4. As far as interaction between egg weight categories and storage period is concerned, significantly ($p \leq 0.05$) higher percent hatch of fertile were observed in large and medium egg weight categories with all the three storage periods in pre-peak and peak production phases. During post-peak and terminal phases, significantly ($p \leq 0.05$) the highest hatch of fertile percent was noted in medium egg weight category with all the storage periods.

Table 1. Average Egg Size (g) (Mean ± SE) as influenced by 3 egg weight categories and storage period at 4 production phases in AA broiler breeder strain

Phases / *S.O.V		Pre-peak	Peak	Post-peak	Terminal
Egg weight categories					
♠L		54.66±0.15[a]	59.57±0.21[a]	67.85±0.08[a]	71.64±0.03[a]
♥M		49.53±0.19[b]	53.81±0.11[b]	61.90±0.11[b]	66.22±0.03[b]
♣S		44.17±0.17[c]	48.11±0.08[c]	56.58±0.11[c]	61.50±0.02[c]
Storage periods					
1-D†		49.43±0.53	53.82±0.41	62.10±0.29	66.43±0.49
4-D		49.45±0.54	53.82±0.41	62.12±0.28	66.46±0.49
7-D		49.48±0.54	53.85±0.42	62.11±0.28	66.46±0.49
Interaction					
	1-D	54.56±0.29[a]	59.53±0.37[a]	67.84±0.13[a]	71.65±0.05[a]
L	**4-D**	54.67±0.26[a]	59.52±0.36[a]	67.85±0.13[a]	71.62±0.06[a]
	7-D	54.76±0.26[a]	59.65±0.37[a]	67.84±0.12[a]	71.63±0.05[a]
	1-D	49.53±0.32[b]	53.82±0.19[b]	61.89±0.19[b]	66.20±0.06[b]
M	**4-D**	49.53±0.34[b]	53.81±0.20[b]	61.90±0.19[b]	66.23±0.06[b]
	7-D	49.54±0.33[b]	53.80±0.19[b]	61.90±0.19[b]	66.24±0.05[b]
	1-D	44.20±0.29[c]	48.12±0.14[c]	56.57±0.18[c]	61.46±0.05[c]
S	**4-D**	44.16±0.31[c]	48.12±0.14[c]	56.61±0.19[c]	61.53±0.04[c]
	7-D	44.15±0.33[c]	48.09±0.13[c]	56.57±0.18[c]	61.51±0.05[c]

Different alphabets [a-c] in a column show significant differences ($p \leq 0.05$); *S.O.V = Source of variance, ♠L = Large, ♥M = medium, ♣S = Small, †D = Days

Table 2. Moisture Loss percent (Mean ±SE) as influence by 3 egg weight categories and storage period at 4 production phases in AA broiler breeder strain

Phases / *S.O.V		Pre-Peak	Peak	Post-Peak	Terminal
		Egg weight categories			
♠L		10.43±0.07	10.51±0.05	$10.75±0.03^{a}$	10.95±0.07
♥M		10.47±0.07	10.58±0.04	$10.55±0.02^{b}$	11.16±0.08
♣S		10.57±0.06	10.56±0.05	$10.73±0.03^{a}$	10.94±0.15
		Storage periods			
1-D†		$10.21±0.05^{b}$	$10.31±0.04^{c}$	$10.68±0.03^{b}$	$10.62±0.15^{c}$
4-D		$10.37±0.07^{b}$	$10.51±0.05^{b}$	$10.12±0.02^{c}$	$11.05±0.07^{b}$
7-D		$10.90±0.05^{a}$	$10.84±0.05^{a}$	$10.80±0.03^{a}$	$11.38±0.07^{a}$
		Interaction			
L	1-D	$10.10±0.11^{d}$	$10.39±0.08^{cd}$	$10.77±0.06^{c}$	$10.61±0.08^{bc}$
	4-D	$10.45±0.14^{c}$	$10.29±0.06^{d}$	$10.62±0.05^{cd}$	$10.98±0.12^{ab}$
	7-D	$10.75±0.10^{b}$	$10.86±0.07^{a}$	$10.86±0.05^{b}$	$11.27±0.11^{a}$
M	1-D	$10.27±0.08^{cd}$	$10.27±0.05^{d}$	$10.49±0.05^{d}$	$11.00±0.17^{ab}$
	4-D	$10.27±0.14^{cd}$	$10.58±0.09^{bc}$	$10.58±0.05^{d}$	$11.02±0.14^{ab}$
	7-D	$10.89±0.10^{ab}$	$10.90±0.08^{a}$	$10.59±0.05^{d}$	$11.46±0.12^{a}$
S	1-D	$10.25±0.09^{cd}$	$10.26±0.05^{d}$	$10.78±0.04^{c}$	$10.26±0.38^{c}$
	4-D	$10.40±0.10^{cd}$	$10.67±0.09^{ab}$	$10.49±0.05^{d}$	$11.16±0.10^{a}$
	7-D	$11.07±0.09^{a}$	$10.76±0.10^{ab}$	$10.94±0.06^{a}$	$11.42±0.15^{a}$

Different alphabets $^{a-d}$ in a column show significant differences (p≤0.05): *S.O.V = Source of variance, ♠L = Large, ♥M = medium, ♣S = Small, †D = Days

Table 3. Fertility percent (Mean ±SE) as influence by 3 egg weight categories and storage period at 4 production phases in AA broiler breeder strain

Phases / *S.O.V		Pre-Peak	Peak	Post-Peak	Terminal
		Egg weight categories			
♠L		$69.69±1.22^{a}$	$91.89±0.13^{a}$	$86.94±0.06^{c}$	$83.33±0.15^{b}$
♥M		$68.69±1.47^{b}$	$90.26±0.10^{b}$	$89.16±0.11^{a}$	$84.04±0.13^{a}$
♣S		$66.76±1.38^{c}$	$85.84±0.11^{c}$	$87.54±0.29^{b}$	$83.75±0.11^{b}$
		Storage periods			
1-D†		68.20±1.36	89.31±0.24	87.68±0.29	83.63±0.13
4-D		68.79±1.36	89.36±0.24	88.01±0.11	83.79±0.15
7-D		68.15±1.39	89.31±0.25	87.97±0.11	83.69±0.12
		Interaction			
L	1-D	$69.37±2.15^{ab}$	$91.83±0.23^{a}$	$87.01±0.11^{bc}$	$83.12±0.29^{c}$
	4-D	$69.83±2.12^{a}$	$91.95±0.24^{a}$	$86.92±0.11^{c}$	$83.54±0.32^{bc}$
	7-D	$69.87±2.15^{a}$	$91.89±0.23^{a}$	$86.90±0.11^{c}$	$83.33±0.18^{abc}$
M	1-D	$68.54±2.59^{ab}$	$90.27±0.16^{b}$	$89.13±0.17^{a}$	$84.12±0.17^{a}$
	4-D	$68.70±2.60^{ab}$	$90.29±0.14^{b}$	$89.18±0.18^{a}$	$84.13±0.28^{a}$
	7-D	$68.83±2.59^{ab}$	$90.22±0.22^{b}$	$89.16±0.19^{a}$	$83.87±0.24^{ab}$
S	1-D	$66.70±2.39^{cd}$	$85.85±0.19^{c}$	$86.89±0.84^{c}$	$83.66±0.18^{abc}$
	4-D	$67.83±2.39^{bc}$	$85.85±0.17^{c}$	$87.90±0.16^{b}$	$83.70±0.16^{abc}$
	7-D	$65.75±2.47^{d}$	$85.81±0.18^{c}$	$87.84±0.17^{cb}$	$83.87±0.22^{ab}$

Different alphabets $^{a-d}$ in a column show significant differences (p≤0.05); *S.O.V = Source of variance, ♠L = Large, ♥M = medium, ♣S = Small, †D = Days

Table 4. Hatchability percent (Mean ±SE) as influence by 3 egg weight categories and storage period at 4 production phases in AA broiler breeder strain

Phases / *S.O.V		Pre-Peak	Peak	Post-Peak	Terminal
Egg weight categories					
♠L		62.69 ± 1.26^{a}	87.72 ± 0.14^{a}	81.61 ± 0.07^{c}	75.00 ± 0.16^{b}
♥M		61.69 ± 1.53^{b}	86.09 ± 0.11^{b}	83.82 ± 0.11^{a}	75.71 ± 0.15^{a}
♣S		59.26 ± 1.43^{c}	81.67 ± 0.11^{c}	82.21 ± 0.29^{b}	75.41 ± 0.12^{a}
Storage periods					
1-D†		61.04±1.42	85.31 ± 0.24^{a}	82.68 ± 0.29^{a}	75.63 ± 0.13^{a}
4-D		61.62±1.41	85.36 ± 0.24^{a}	83.01 ± 0.11^{a}	75.69 ± 0.15^{a}
7-D		60.98±1.44	84.81 ± 0.25^{b}	81.97 ± 0.11^{b}	74.69 ± 0.12^{b}
Interaction					
	1-D	62.37 ± 2.23^{a}	87.83 ± 0.23^{a}	82.01 ± 0.11^{c}	75.12 ± 0.29^{bc}
L	4-D	62.83 ± 2.20^{a}	87.95 ± 0.24^{a}	81.92 ± 0.11^{c}	75.54 ± 0.32^{abc}
	7-D	62.87 ± 2.23^{a}	87.39 ± 0.23^{a}	80.90 ± 0.11^{d}	74.33 ± 0.18^{d}
	1-D	61.54 ± 2.69^{ab}	86.27 ± 0.15^{b}	84.13 ± 0.17^{a}	76.12 ± 0.17^{a}
M	4-D	61.70 ± 2.70^{ab}	86.29 ± 0.14^{b}	84.18 ± 0.19^{a}	76.12 ± 0.28^{a}
	7-D	61.83 ± 2.69^{ab}	85.72 ± 0.22^{b}	83.16 ± 0.18^{b}	74.87 ± 0.23^{cd}
	1-D	59.20 ± 2.50^{cd}	81.85 ± 0.19^{c}	81.89 ± 0.83^{c}	75.66 ± 0.18^{ab}
S	4-D	60.33 ± 2.49^{bc}	81.85 ± 0.17^{c}	82.90 ± 0.16^{b}	75.70 ± 0.16^{ab}
	7-D	58.25 ± 2.56^{d}	81.31 ± 0.18^{c}	81.84 ± 0.17^{c}	74.87 ± 0.22^{cd}

Different alphabets $^{a-d}$ in a column show significant differences ($p\leq0.05$); *S.O.V = Source of variance, ♠L = Large, ♥M = medium, ♣S = Small, †D = Days

Table 5. Hatch of fertile percent (Mean ± SE) as influence by 3 egg weight categories and storage period at 4 production phases in AA broiler breeder strain

Phases / *S.O.V		Pre-Peak	Peak	Post-Peak	Terminal
Egg weight categories					
♠L		89.68 ± 0.23^{a}	95.46 ± 0.02^{a}	93.86±0.03	89.99 ± 0.07^{b}
♥M		89.33 ± 0.31^{b}	95.38 ± 0.02^{b}	94.01±0.03	90.08 ± 0.07^{a}
♣S		88.29 ± 0.32^{c}	95.41 ± 0.03^{c}	93.75±0.17	90.05 ± 0.06^{a}
Storage periods					
1-D†		89.07±0.30	95.51 ± 0.01^{a}	94.14 ± 0.10^{a}	90.43 ± 0.01^{a}
4-D		89.17±0.29	95.51 ± 0.01^{a}	94.31 ± 0.01^{a}	90.45 ± 0.02^{a}
7-D		89.05±0.30	94.95 ± 0.01^{b}	93.17 ± 0.01^{b}	89.24 ± 0.02^{b}
Interaction					
	1-D	89.63 ± 0.40^{ab}	95.64 ± 0.01^{a}	94.25 ± 0.01^{ab}	90.37 ± 0.03^{b}
L	4-D	89.70 ± 0.40^{a}	95.64 ± 0.01^{a}	94.24 ± 0.01^{ab}	90.42 ± 0.04^{ab}
	7-D	89.70 ± 0.40^{a}	95.10 ± 0.01^{d}	93.09 ± 0.01^{c}	89.20 ± 0.02^{c}
	1-D	89.31 ± 0.54^{c}	95.57 ± 0.01^{b}	94.39 ± 0.01^{a}	90.49 ± 0.02^{a}
M	4-D	89.33 ± 0.55^{c}	95.57 ± 0.01^{b}	94.39 ± 0.01^{a}	90.48 ± 0.03^{a}
	7-D	89.36 ± 0.54^{bc}	95.00 ± 0.01^{e}	93.26 ± 0.01^{c}	89.27 ± 0.03^{c}
	1-D	88.28 ± 0.57^{ed}	95.33 ± 0.01^{c}	93.77 ± 0.52^{b}	90.43 ± 0.02^{ab}
S	4-D	88.48 ± 0.56^{d}	95.33 ± 0.01^{c}	94.31 ± 0.01^{a}	90.44 ± 0.02^{ab}
	7-D	88.10 ± 0.57^{e}	94.75 ± 0.01^{f}	93.16 ± 0.01^{c}	89.26 ± 0.03^{c}

Different alphabets $^{a-f}$ in a column show significant differences ($p\leq0.05$); *S.O.V = Source of variance, ♠L = Large, ♥M = medium, ♣S = Small, †D = Days

Conclusions: Egg size and fertility had positive relationship with egg weight, whereas, storage had no effect on egg size and fertility. Moisture loss had positive relationship with storage length, but having no particular trend with egg weight. Significantly the highest hatchability and hatch of fertile percent were observed in large egg weight category during pre and post- peak, while, medium egg weight category showed higher hatchability and hatch of fertile % during post-peak and terminal phases. Significantly higher hatchability and hatch of fertile percent were observed in one and four day storage period. Based on the findings of the present study, it may be stated that large egg weight category with 1 or 4 days storage period had maximum fertility, hatchability and hatch of fertile percent.

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