Effect of Age of Parents and Hatching Egg Weight on Broiler Chick Mortality

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ABSTRACT A total of 7400 mixed-sex broilers was used in two experiments to determine the effect of breeder age and hatching egg weight on chick mortality and weight. In each experiment, 925 chicks were housed after hatching from either 29-week-old breeder hen eggs weighing either 47–54 or 57–62 grams or 58-week-old breeder hen eggs weighing either 57–62 or 67–74 grams.

Higher mortality occurred when chicks were hatched from 29-week-old breeder hen eggs as compared to eggs from 58-week-old breeders. Also, higher mortality occurred when chicks were hatched from eggs weighing 47–54 grams compared to either 57–62 or 67–74 gram hatching eggs.

Larger market broiler weights were found when chicks were hatched from either 57–62 or 67–74 gram eggs compared to chicks hatched from 47–54 gram eggs. No significant differences in market body weights due to age of parents were found when egg weights were comparable.

INTRODUCTION

Broiler chick mortality is of major concern to the poultry industry because profit margins of the integrated industry are influenced by mortality of broilers to eight weeks of age. Skoglund *et al.* (1952) found that broiler chicks from eggs weighing less than 50 grams are not as profitable as chicks from larger eggs. They further stated, however, that in periods of egg scarcity the smaller eggs can be used particularly if both unfavorable shipping and early brooding conditions can be avoided.

Godfrey and Williams (1952) found that 74% of the observed variation in body weight at market age is accounted for by size of the egg from which the chick is hatched, age at sexual maturity and mature body size. The size of the egg from which the chick was hatched exerted by far the greatest influence.

Wiley (1950), O'Neil (1955), Goodwin (1961), and Gardiner (1973) suggested that the size of a chick at hatching has an important effect on its growth to market age. Goodwin (1961) stated the intial effect of egg weight on subsequent growth to market age is of sufficient magnitude to be of practical importance to the broiler industry. A positive correlation of hatching egg weight and broiler weight is apparent even at time of hatching (Benjamin, 1920; Halbersleben and Mussehl, 1922; Jull and Quinn, 1925; Upp, 1928; Galpin, 1938; Penquite and Milby, 1941; Kosin *et al.*, 1952; Merritt and Gowe, 1965; and Gardiner, 1973).

Marble (1939) emphasized the value of using older hens when breeding for high viability. Hays and Spear (1952) showed that broiler chick mortality from young breeders was significantly higher than was observed in chicks from older breeders. These researchers did not equalize egg weights. Therefore, results of Hays and Spear (1952) should not be interpreted as a direct correlation of age of parents and subsequent chick mortality.

Skoglund and Tomhave (1949) and Wiley (1950) found no relationship of egg weight and mortality. In contrast, O'Neil (1955) concluded that those chicks hatching with the highest percentage of the original weight of the egg are heavier at eight weeks of age, more efficient in feed consumption, and have a lower mortality. Skoglund *et al.* (1952) showed a trend toward higher mortality in chicks hatched from small eggs, but found no significant differences in mortality due to egg weight.

Tindell and Morris (1964) found that egg weight groups, when intermingled, tended to have greater mortality and weigh less when compared to the same egg weight groups penned separately. However, they found no differences in mortality due to hatching egg

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weight.

In previous research conducted to show the correlation of age of parents and subsequent chick mortality, egg weights were not equated to determine whether the cause of mortality is egg weight or age of parents. Therefore, experiments were conducted to determine the effect of egg weight and age of parents on chick mortality.

EXPERIMENTAL PROCEDURE

Two experiments were conducted to determine the effect of hatching egg weight and age of parents on chick mortality and chick weight. Forty eggs from each test group were pooled and analyzed for yolk moisture and fat. Twenty-five one-day-old chicks from each test group were ground and composite body moisture and fat were determined.

In each experiment, 3700 mixed-sex broilers were housed in an environmentally-controlled broiler house using solar heat as the energy source and partial house brooding techniques developed by Reece (1977). Average broiler house temperatures in Experiment 1 were 29.4, 28.9, 26.1, 25.0, 23.3, 23.9, 24.4, and 23.9°C. for weeks 1 through 8, respectively. In Experiment 2, average broiler house temperatures were 27.8, 26.7, 25.0, 22.8, 22.8, 22.8, 23.9, and 23.9°C. for week 1 through 7 weeks and four days, respectively. Tindell and Morris (1964) found that chicks hatched from various egg weight groups, when intermingled, tended to have greater mortality when compared to the same egg weight groups penned separately. Birds hatched from all egg weight groups in this study were toe clipped for identification and intermingled.

Nine hundred and twenty-five chicks were housed which were hatched from 29-week-old breeder eggs weighing either 47–54 or 57–62 grams, or hatched from 58-week-old breeder eggs weighing either 57–62 or 67–74 grams. Eggs weighing approximately the same (57–62 grams) were used to compare effect of age of parent on their offspring's mortality. Frequency distribution and percentage of eggs represented in each egg weight group are shown in Table 1.

Starter and finisher mash feeds fed from one day of age to eight weeks of age in Experiment 1 and seven weeks, four days in Experiment 2 are shown in Table 2. Since the poultry industry is marketing birds at an earlier age, broilers in Experiment 2 were weighed at seven

TABLE 1.—*Frequency distribution of 29- and 58-week-old breeder eggs*

Hatching egg weight, g.	Breeder age, wks. 29	58
	Frequency distribution, %	
<47	0.19	0
47-48	0.38 [1]	0
49-50	4.15	0
51-52	12.81	0.21
53-54	16.38	0.42
55-56	16.40	0.21
57-58	16.74	1.66
59-60	16.20	4.35
61-62	11.49	11.80
63-64	2.45	21.51
65-66	1.13	12.01
67-68	1.13	14.06
69-70	0.19	12.63
71-72	0	9.32
73-74	0	7.04
75-76	0	2.90
77-78	0	1.04
79-80	0.19	0.42
>80	0.19	0.42
Total	100	100

[1] Populations of eggs taken from each group.

weeks, four days instead of eight weeks. Body weights of 100 birds per test group were determined at 2-week intervals. Coefficients of variability were determined for one-day-old and market age chick weights (Table 4). Mortality was recorded as it occurred. Feed efficiency was not determined because all test groups were intermingled. Average ambient outside temperature at day of housing was 17.2°C. in Experiment 1 and 4.4°C. in Experiment 2.

Statistical examination of the data, other than mortality, was performed using the analysis of variance (Steel and Torrie, 1960). Duncan's new multiple range test (1955) was used to separate significant differences between means. Mortality was analyzed by Chi Square. All statements of significance refer to the 5% level of probability.

RESULTS AND DISCUSSION

Two experiments were conducted to determine the effect of age of parents and hatching egg weight on chick mortality. Mortality results are shown in Table 3. In both experiments, higher mortality was observed in chicks hatched

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TABLE 2.—*Composition of starter and finisher diets*

Ingredient	Type of ration: Starter (0-4 wks.)	Finisher (4-8 wks.)
	%	%
Yellow corn	53.51	57.02
Soybean meal, 49%	37.39	34.00
Animal fat	5.88	5.88
Defluorinated phos. (18.0% P., 30.0% Ca.)	2.02	1.93
Limestone	.31	.32
Salt	.30	.30
Trace nutrient premix[1]	.25	.25
Methionine hydroxy analogue-Ca, 93%	.29	.25
Zoalene (3,5 dinitro-O-toluamide, 25%)	.05	.05
Total	100	100
Calculated analysis:		
Crude protein, %	23.03	21.68
Metabolizable energy, kcal./kg.	3194	3234
Total calcium, %	.85	.82
Available phosphorus, %	.46	.44
Meth. + cyst., %	.98	.91
Lysine, %	1.30	1.20

[1] The broiler premix furnished the following amounts of other ingredients per kilogram of feed: vitamin A palmitate, gelatin coated, 6614 IU; vitamin D-3, 1654 ICU; vitamin E, 2.2 IU; riboflavin, 4.4 mg; niacin, 27.6 mg.; d-pantothenic acid, 8.8 mg.; folic acid, 275.6 mcg.; vitamin B-12, 8.8 mcg.; choline chloride, 551 mg.; ethoxyquin, 55 mg.; menadione sodium bisulfite complex, 2.8 mg.; pyridoxine, 0.55 mg.; manganese, 66.25 mg.; zinc, 44 mg.; iodine, 1.25 mg.; iron (in sulfate form), 20 mg.; copper (in sulfate form), 2 mg.

from 29-week-old breeder eggs. Hays and Spear (1952) did not equalize egg weight; therefore, a direct correlation of chick mortality and age of parents could not be determined. Mortality data in this study do confirm that age of parents influence offspring's mortality because higher mortality occurred in chicks hatched from 29-week-old breeder eggs as compared to 58-week-old breeder eggs when egg weights remained the same. Therefore, a more viable chick was apparently produced from 58-week-old breeders. Similar conclusions were made by

TABLE 3.—*Effect of breeder age and hatching egg weight on chick mortality*

Breeder age: egg wt.	Mortality, % (weeks of age): 1	2	3	4–8	Total[1]
Experiment 1					
29 wks.: 47–54 g.	3.35	1.56	.23	1.02	6.16[c]
29 wks.: 57–62 g.	2.49	.78	.22	.78	4.27[b]
58 wks.: 57–62 g.	1.51	.55	.33	.88	3.27[ab]
58 wks.: 67–74 g.	1.62	.55	.33	.44	2.94[a]
Experiment 2					
29 wks.: 47–54 g.	5.40	.91	0	.81	7.12[b]
29 wks.: 57–62 g.	4.22	.34	.22	1.14	5.92[b]
58 wks.: 57–62 g.	1.51	.11	.33	.22	2.17[a]
58 wks.: 67–74 g.	1.62	.22	0	.77	2.61[a]

[1] Means within a column grouping and without a common superscript are significantly different ($P<0.05$) as determined by Chi Square.

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TABLE 4.—*Effect of breeder age and hatching egg weight on body weights*

	Average body weight, g.					
		Age, weeks			Market age[2,3]	
Breeder age: egg wt.	1 day old (C.V.)[1]	2	4	6	♀ (C.V.)[1]	♂ (C.V.)
Experiment 1						
29 wks.: 47–54 g.	33 (4.85)	208	573	1205	1598^{b} (10.65)	1985^{b} (11.25)
29 wks.: 57–62 g.	37 (3.98)	224	629	1233	1668^{a} (9.75)	2044^{ab} (10.87)
58 wks.: 57–62 g.	38 (5.74)	227	611	1248	1698^{a} (10.98)	2058^{ab} (10.01)
58 wks.: 67–74 g.	44 (4.86)	240	651	1325	1717^{a} (11.87)	2098^{a} (9.89)
Experiment 2						
29 wks.: 47–54 g.	33 (3.80)	212	610	1292	1480^{b} (10.40)	1831^{a} (10.27)
29 wks.: 57–62 g.	36 (5.57)	229	666	1334	1591^{a} (9.97)	1889^{a} (10.24)
58 wks.: 57–62 g.	37 (4.62)	230	651	1348	1572^{a} (9.80)	1875^{a} (11.13)
58 wks.: 67–74 g.	43 (5.33)	248	678	1400	1591^{a} (11.70)	1892^{a} (9.67)

[1] Coefficient of variability.

[2] Market age in Experiment 1 was eight weeks and Experiment 2 was seven weeks, four days.

[3] Means within a column grouping and without a common superscript are significantly different ($P<0.05$) as determined by Duncan's New Multiple Range Test.

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Marble (1939) and Hays and Spear (1952).

Higher mortality was observed when chicks were hatched from 29-week-old breeder eggs weighing 47–54 grams as compared to eggs weighing 57–62 grams. These values were significant in Experiment 1 and approached significance in Experiment 2. No significant differences were found in mortality when chicks were hatched from 58-week-old breeder eggs weighing either 57–62 grams or 67–74 grams. Marble (1939) and O'Neil (1955) have produced similar results. However, other researchers (Skoglund and Tomhave, 1949; Wiley, 1950; and Tindell and Morris, 1964) did not find the correlation of egg weight and mortality. Approximately 60% of the total chick mortality in this study occurred the first week, 15% occurred the second week, and 25% occurred the last 6 weeks.

Chick weights at hatching (Table 4) increased as hatching egg weights increased. No differences in one-day-old chick weights were found due to age of parents when egg weights remained the same. Therefore, results indicate that age of parents have no influence on chick weights. These results agree with findings of Kosin *et al.* (1952), Merritt and Gowe (1965), Wiley (1950), and Gardiner (1973). Wiley (1950) found chick size to be limited significantly by the space in the egg shell during the last 2 or 3 days of incubation. Therefore, it seems logical that only hatching egg size limits chick weights at hatching and not age of parents.

Significantly larger market weights of females (Table 4) were found when chicks were hatched from eggs weighing either 57–62 or 67–74 grams when compared to eggs weighing 47–54 grams. In Experimemt 1, significantly larger market weights of males were found when chicks were hatched from hatching eggs weighing 67–74 grams as compared to 47–54 grams. No significant differences in market weights of males were found in Experiment 2.

No significant differences in market body weights due to age of parents were found when hatching egg weights remained the same, thus reinforcing work by Wiley (1950). Also in this study, market weight results reinforces results obtained at day-old in respect to lack of effects on body weight found due to age of parents. Body weight coefficients of variation were greater at market age than were found at hatching. The correlation of egg weight to chick weights at hatching and market weights are similar to results reported by O'Neil (1955), Goodwin (1961), and Gardiner (1973).

Hatchability (Table 5) decreased as egg weights increased. The results compare with data reported by Insko *et al.* (1947) and Hays (1955a). No significant differences in hatchability were found due to age of parents when egg weights remained the same. No significant differences in hatchability were found between experiments.

Significantly lower egg yolk fat values (Table 6) were found in 29-week-old breeder eggs weighing 47–54 grams as compared to 58-week-old breeder eggs weighing 67–74 grams. No significant differences in egg yolk fat were found due to age of parents when egg weights remained the same. Also, no significanct differences in yolk moisture was found. Yolk moisture tended to decrease as egg weight decreased.

Hays (1955b) explained that the reason for high mortality from chicks hatched from young parents was that older parents are likely to produce the more viable chicks. One possible

TABLE 5.–*Effect of breeder age and hatching egg weight on hatchability*

Breeder age: egg wt.	Hatchability, % Experiment 1	2	Mean[1]
29 wks.: 47–54 g.	86.1	85.9	86.0[a]
29 wks.: 57–62 g.	81.4	79.2	80.3[b]
58 wks.: 57–62 g.	80.7	82.0	81.4[b]
58 wks.: 67–74 g.	76.6	74.3	75.4[c]
Mean	81.2	80.4	

[1] Means within a column and without a common superscript are significantly different (P<0.05) as determined by Duncan's New Multiple Range Test.

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TABLE 6.—*Effect of breeder age and egg weight on egg yolk and one-day-old broiler body fat and moisture*

	Test results			
	Egg yolk[1]		One-day-old broilers[1]	
Breeder age: egg wt.	Fat, %[2]	Moisture, %[3]	Body fat, %[2]	Body moisture, %[3]
Experiment 1				
29 wks.: 47–54 g.	32.19^{b}	47.92^{a}	3.54^{b}	76.34^{a}
29 wks.: 57–62 g.	33.96^{a}	46.52^{a}	3.58^{b}	76.16^{a}
58 wks.: 57–62 g.	33.27^{ab}	47.24^{a}	5.39^{a}	74.32^{b}
58 wks.: 67–74 g.	34.56^{a}	46.60^{a}	5.57^{a}	74.27^{b}
Experiment 2				
29 wks.: 47–54 g.	32.51^{b}	48.40^{a}	3.01^{b}	75.03^{a}
29 wks.: 57–62 g.	33.87^{ab}	47.22^{a}	3.14^{b}	73.69^{a}
58 wks.: 57–62 g.	33.93^{ab}	48.18^{a}	4.54^{a}	73.34^{a}
58 wks.: 67–74 g.	34.84^{a}	47.43^{a}	4.77^{a}	72.41^{a}

[1] Means within a column grouping and without a common superscript are significantly different ($P<0.05$) as determined by Duncan's New Multiple Range Test.

[2] Body and yolk fat is calculated on a wet weight basis.

[3] Wet weight basis.

explanation to a more viable chick being produced from older parents is that significantly more body fat (Table 6) was found in one-day-old chicks hatched from 58-week-old breeder eggs as compared to chicks hatched from 29-week-old breeder eggs when hatching egg weights remained the same. As would be expected, body moisture decreased as body fat increased. However, these moisture values were not significant in Experiment 2.

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