The Effect of Temperature During the Growing Period on Broiler Performance

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ABSTRACT Data are presented concerning the effect of environmental temperature during the growing period on broiler performance so that industry would have guidelines for economic evaluations when decisions are made concerning broiler house modifications and fuel or feed use. Normal body weight gain was attained for broilers reared in the lower temperature regimes when compared to broilers reared in a 21.1 C temperature; however, feed conversion increases for the lower temperature-reared groups. Growth rate was lower for broilers reared at a simulated summer temperature regime than for those reared at 21.1 C.

INTRODUCTION

Studies by Barott and Pringle (1949, 1950), Ota and Garver (1954), Prince *et al.* (1960), and Howes *et al.* (1962) indicated that the optimum environmental temperature for growing broilers decreased to approximately 12.8 to 18.3 C at four to five weeks of age. Deaton *et al.* (1968) showed that when broilers are reared for the last five weeks in temperature regimes above approximately 26.7 C for one-half the time or more, body weight gain was significantly reduced as compared to broilers reared in temperature regimes below 26.7 C.

As feed and fuel continue to increase in price, more emphasis is being placed on broiler house environmental control. Most of the feed required in the production of broilers is consumed from three or four weeks of age to market. Since feed accounts for 60 to 75% of the total production cost of broilers, data are needed by the industry to show the effect of environmental temperature on broilers. Therefore, the following study was conducted to show the effect of house temperature on broiler performance during the growing period.

MATERIALS AND METHODS

For each of three trials, commercial broiler chicks were reared from one day to four weeks of age as a group using electric infrared brooders. At four weeks of age, the broilers for each trial were placed in four environmental-controlled chambers based on a design described by Reece and Deaton (1969). Mixed-sex broilers were used with 40 males and 40 females placed in each chamber for each treatment group of each trial. Each environmental-controlled chamber represented a temperature treatment. The experiment was replicated with trials at differing times. The hatch date for the chicks for each of the three trials was November 24, 1976, February 16, 1977, and April 19, 1977, respectively. Body weights of the four-week-old broilers were equated for each treatment group at the beginning of each trial. The average bird weight for the four treatments at four weeks of age did not differ more than one gram.

The four treatments consisted of commercial broilers reared from four to eight weeks of age in temperatures of 1) constant 10 C with a 4.4 C dewpoint, 2) constant 15.6 C with a 10 C dewpoint, 3) constant 21.1 C with a 15.6 C dewpoint, and 4) a 24-hr linear temperature cycle ranging from 23.9 to 35 to 23.9 C with a constant dewpoint of 21.1 C. Treatment 4 was used to simulate a summer temperature regime that is prevalent in the Southeastern United States (Reece *et al.*, 1969). Dewpoint temperatures simulated those that commonly occur with the temperature used (Harwood and Reece, 1974). Deaton and Reece (1970) previously showed that broilers reared at a constant temperature of 23.9 C had significantly lower body weights than broilers reared at 18.3 C; therefore, we did not use a constant temperature regime above 21.1 C.

New pine shavings were used for litter in each trial and for each treatment group. Light was supplied by incandescent bulbs. Light intensity was continuous at 12.9 lux. Two 38.1 cm diameter tube feeders were used in each

TABLE 1.—*Temperature effect on broiler growth and feed conversion*

Treatment[d]	Age (weeks)	Trial	Average body weight (g)			Feed conversion
			Male	Female	Mean	
	0–4	1	661	601	631	1.70
	0–4	2	672	588	630	1.64
	0–4	3	784	673	729	1.45
	0–4	$\bar{X}$	706	621	663	1.60
1	0–7	1	1661	1357	1509	2.00
	0–7	2	1791	1481	1636	1.99
	0–7	3	2050	1649	1850	1.91
	0–7	$\bar{X}$	1834[a]	1496[a]	1665	1.97[a]
2	0–7	1	1690	1376	1533	1.95
	0–7	2	1797	1517	1657	1.97
	0–7	3	2098	1728	1913	1.88
	0–7	$\bar{X}$	1862[a]	1540[b]	1701	1.93[ab]
3	0–7	1	1652	1381	1517	1.89
	0–7	2	1879	1505	1692	1.92
	0–7	3	2108	1663	1886	1.86
	0–7	$\bar{X}$	1880[a]	1516[ab]	1698	1.89[bc]
4	0–7	1	1543	1285	1414	1.87
	0–7	2	1764	1428	1596	1.95
	0–7	3	1979	1584	1782	1.81
	0–7	$\bar{X}$	1762[b]	1432[c]	1597	1.88[c]
1	0–8	1	2122	1699	1911	2.21
	0–8	2	2246	1811	2029	2.18
	0–8	3	2457	1968	2213	2.05
	0–8	$\bar{X}$	2275[a]	1826[a]	2051	2.15[a]
2	0–8	1	2138	1757	1948	2.15
	0–8	2	2221	1814	2018	2.16
	0–8	3	2541	2039	2290	1.99
	0–8	$\bar{X}$	2300[a]	1870[b]	2085	2.10[ab]
3	0–8	1	2129	1711	1920	2.04
	0–8	2	2338	1845	2092	2.09
	0–8	3	2542	1980	2261	1.97
	0–8	$\bar{X}$	2336[a]	1845[ab]	2091	2.03[c]
4	0–8	1	1960	1586	1773	2.12
	0–8	2	2103	1689	1896	2.09
	0–8	3	2308	1847	2078	1.96
	0–8	$\bar{X}$	2124[b]	1707[c]	1916	2.06[bc]

[a,b,c]For each column, within each age group, differing letters for each treatment mean ($\bar{X}$) denotes significance at the .05 level of probability.

[d]For each trial, all birds were reared as one group to 4 weeks of age. From 4 to 8 weeks of age, treatments were: 1) a constant 10 C temperature with a 4.4 C dewpoint; 2) a constant 15.6 C temperature with a 10 C dewpoint; 3) a constant 21.1 C temperature with a 15.6 C dewpoint; and 4) a 24 hr linear temperature cycle ranging from 23.9 to 35 to 23.9 C with a constant dewpoint of 21.1 C.

chamber. One 2.44 m waterer was used in each chamber. The waterer was located along one wall so that only one side was available to the birds. A starter diet containing approximately 23% protein and a metabolizable energy value of 3306 kcal/kg of diet was fed for the first four weeks. From four to eight weeks of age, the broilers were fed a diet containing approxi-

TABLE 2.—*Temperature effect on broiler growth and feed conversion*

Treatment[d]	Age (weeks)	Trial	Average body weight (g)			Feed conversion
			Male	Female	Mean	
1	4–7	1	1000	756	878	2.22
	4–7	2	1119	893	1006	2.20
	4–7	3	1266	976	1121	2.20
	4–7	$\bar{X}$	1128[a]	875[a]	1002	2.21[a]
2	4–7	1	1029	775	902	2.13
	4–7	2	1125	929	1027	2.17
	4–7	3	1314	1055	1185	2.14
	4–7	$\bar{X}$	1156[a]	920[b]	1038	2.15[ab]
3	4–7	1	991	780	886	2.02
	4–7	2	1207	917	1062	2.08
	4–7	3	1324	990	1157	2.12
	4–7	$\bar{X}$	1174[a]	896[ab]	1035	2.07[b]
4	4–7	1	882	684	783	2.01
	4–7	2	1092	840	966	2.16
	4–7	3	1195	911	1053	2.06
	4–7	$\bar{X}$	1056[b]	812[c]	934	2.08[b]
1	4–8	1	1461	1098	1280	2.46
	4–8	2	1574	1223	1399	2.42
	4–8	3	1673	1295	1484	2.34
	4–8	$\bar{X}$	1569[a]	1205[a]	1387	2.41[a]
2	4–8	1	1477	1156	1317	2.37
	4–8	2	1549	1226	1388	2.39
	4–8	3	1757	1366	1562	2.24
	4–8	$\bar{X}$	1594[a]	1249[b]	1422	2.33[b]
3	4–8	1	1468	1110	1289	2.20
	4–8	2	1666	1257	1462	2.28
	4–8	3	1758	1307	1533	2.21
	4–8	$\bar{X}$	1631[a]	1225[ab]	1428	2.23[c]
4	4–8	1	1299	985	1142	2.35
	4–8	2	1431	1101	1266	2.31
	4–8	3	1524	1174	1349	2.23
	4–8	$\bar{X}$	1418[b]	1087[c]	1253	2.30[bc]

[a,b,c]For each column, within each age group, differing letters for each treatment mean ($\bar{X}$) denotes significance at the .05 level of probability.

[d]For each trial, all birds were reared as one group to 4 weeks of age. From 4 to 8 weeks of age, treatments were: 1) a constant 10 C temperature with a 4.4 C dewpoint; 2) a constant 15.6 C temperature with a 10 C dewpoint; 3) a constant 21.1 C temperature with a 15.6 C dewpoint; and 4) a 24 hr linear temperature cycle ranging from 23.9 to 35 to 23.9 C with a constant dewpoint of 21.1 C.

mately 21% protein and a metabolizable energy value of 3372 kcal/kg of diet. Feed and water were provided *ad libitum*. Body weight and feed consumption data were recorded at four, seven, and eight weeks of age. Mortality was recorded as it occurred.

The chicks were vent-sexed at the hatchery and the males were toe-clipped for identification. We used analysis of variance (Cochran and Cox, 1957) with Duncan's (1955) multiple range test to separate significant treatment means.

RESULTS AND DISCUSSION

The effect of temperature on broiler growth

and feed conversion is given in Tables 1 and 2. Average body weight gain for male or female broilers reared at lower temperatures did not differ significantly when compared with male or female broilers reared at 21.1 C (Tables 1 and 2). Average body weight gain for female broilers reared at 15.6 C was significantly greater than for average body weight gain of female broilers reared at 10 C (Tables 1 and 2). The amount of feed required per unit of body weight produced (feed conversion) increased for broilers reared in the lower temperatures as compared to broilers reared at 21.1 C (Tables 1 and 2). At the .05 level of probability, the four- to eight-week average feed conversion differed significantly for the groups reared at 21.1, 15.6, and 10 C (Table 2). From zero to seven, zero to eight, and four to seven weeks for broilers reared in 10 C versus 15.6 C, no significant difference existed in average feed conversion (Tables 1 and 2). From zero to seven, zero to eight, and four to seven weeks for broilers reared in 15.6 versus 21.1 C, no significant differences existed in average feed conversion (Tables 1 and 2). Average feed conversion differed significantly between the groups reared at 10 and 21.1 C for the zero to seven, zero to eight, four to seven, and four to eight week periods (Tables 1 and 2). These results agree with those obtained by Deaton *et al.* (1973) for the constant temperature regime treatments.

When broilers were seven or eight weeks old, average body weights were significantly lower for those reared under a simulated summer temperature regime (23.9 to 35 to 23.9 C) in a 24-hr period than for those reared at 21.1 C (Tables 1 and 2). When broilers were from four to seven weeks old, feed conversion for those reared under the high cyclic temperature regime was essentially the same as that for broilers reared at 21.1 C (Tables 1 and 2). However, about two additional days growing time would be needed for the broilers reared in the high cyclic temperature to obtain the same weight as broilers reared at 21.1 C when they were from four to seven weeks old.

When broilers were eight weeks old, feed conversion was higher for those reared under the high cyclic temperature regime than for broilers reared at 21.1 C (Tables 1 and 2). Feed conversion rates differed numerically, even though the broilers reared at 21.1 C weighed an average of 175 g more at eight weeks of age than the broilers reared under the high cyclic temperature regime. This difference in feed conversion rate shows the adverse effect that summer temperature has on broiler performance, especially if a large broiler is produced during the summer months as compared to moderate temperature growing conditions. About four additional days growing time would be needed for the broilers reared in the high cyclic temperature to attain the same weight as broilers reared at 21.1 C from four to eight weeks of age.

Broilers are generally sold at a specific weight rather than at a specific age. Therefore, broilers are kept on feed longer under summer temperature conditions than under moderate temperature conditions and marketed at an older age. For each additional day that a broiler is kept on feed to reach a specific weight, feed conversion increases two points (.02 g feed/g body weight) per day (Deaton *et al.*, 1976). Mortality was one bird in each of the three trials during the experimental period.

These data are presented so that industry might have guidelines for economic evaluations when decisions are made concerning broiler house modifications and fuel or feed use.

REFERENCES

Barott, H. G., and E. M. Pringle, 1949. The effect of temperature and humidity on environment during the first 18 days after hatch. J. Nutr. 37:153–161.

Barott, H. G., and E. M. Pringle, 1950. The effect of temperature of environment during the period from 18 to 32 days of age. J. Nutr. 41:25–30.

Cochran, G., and G. M. Cox, 1957. Experimental design. John Wiley and Sons, Inc., New York, NY.

Deaton, J. W., and F. N. Reece, 1970. Implications of environmental control for broilers. Feedstuffs 42 (36):34–36.

Deaton, J. W., F. N. Reece, L. F. Kubena, and J. L. McNaughton, 1976. Environmental effects on nutrient requirements of poultry. Page 72–79 *in* Proc. Ark. Nutr. Conf.

Deaton, J. W., F. N. Reece, L. F. Kubena, J. D. May, and T. H. Vardaman, 1973. The effect of low versus moderate rearing temperature on broiler performance. Poultry Sci. 52:1175–1178.

Deaton, J. W., F. N. Reece, and T. H. Vardaman, 1968. The effect of temperature and density on broiler performance. Poultry Sci. 47:293–300.

Duncan, D. B., 1955. Multiple range and multiple F tests. Biometrics 11:1–42.

Harwood, F. W., and F. N. Reece, 1974. Summer ventilation design for insulated windowless broiler houses in southern regions of the United States. Poultry Sci. 53:2148–2152.

Howes, J. R., W. Grub, and C. A. Rollo, 1962. The effects of constant high temperature regimes upon broiler growth, feed efficiency, body composition and carcass quality. Poultry Sci. 41:1652.

Ota, H., and H. L. Garver, 1954. Studies on the growth of baby chicks to frying chickens in the poultry calorimeters. Proc. Ann. Mtg. Amer. Soc. Agr. Eng., Minneapolis, MN.

Prince, R. P., W. C. Wheller, W. A. Junnila, L. M. Potter, and E. P. Singsen, 1960. Effects of temperature on feed consumption and weight gain in broiler performance. Conn. Agr. Exp. Sta. Prog. Rep. 33.

Reece, F. N., and J. W. Deaton, 1969. Environmental control for poultry research. Agr. Engin. 50:670–671.

Reece, F. N., J. W. Deaton, and C. W. Bouchillon, 1969. Heat and moisture production of broilers. 1. Summer conditions. Poultry Sci. 48:1297–1303.