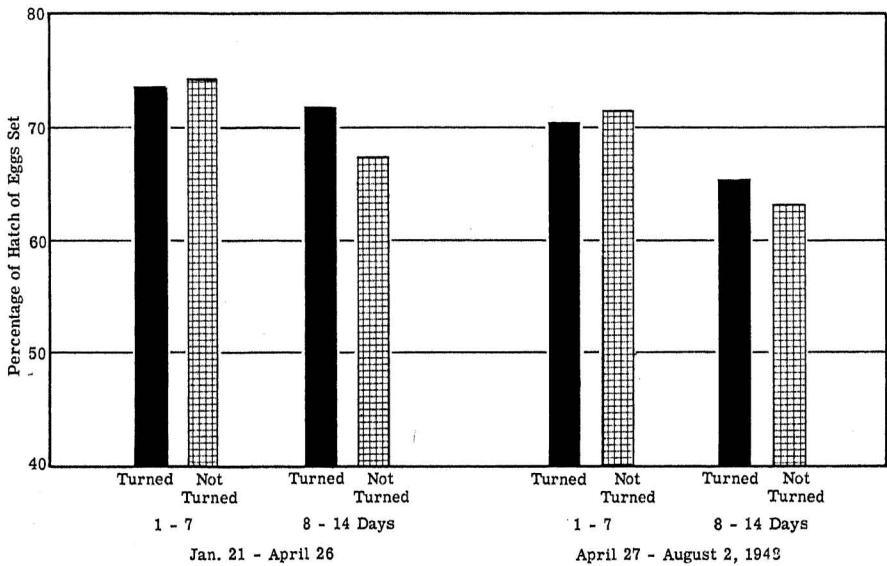


# EFFECT OF HUMIDITY AND TURNING OF EGGS BEFORE INCUBATION ON HATCHING RESULTS

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BULLETIN 554

COLUMBIA, MISSOURI

MAY, 1951

## CONCLUSIONS

Though the percentage of hatch of all eggs set is not greatly increased by high humidity (80 to 90 per cent) during the holding period, generally, high humidity does give best hatching results as measured by the percentage of hatch, the time of hatch, and the quality of the chicks hatched. Data obtained in this experiment justify the use of high humidity for holding hatching eggs. The hatchability of eggs which showed a high rate of evaporation (poor shell quality) was maintained best by high humidity.

These data indicated that high humidity before incubation may be more important at higher temperatures particularly for some breeds (purebred New Hampshires).

Though the data indicate that high humidity prior to incubation may be more important for large eggs than for small eggs, they do not provide a conclusive answer to that problem.

Eggs incubated where the relative humidity was approximately 58% hatched significantly better than eggs incubated with 40% relative humidity.

The hatchability of eggs held at proper temperature for 10 days or less was not increased by turning. The data justify the conclusion that such eggs should not be turned. However, the hatchability of eggs held longer than 10 days (11 to 14 days) is increased appreciably by turning and more significantly so by turning daily from the day they are laid.

Table 1.--Effect of Humidity Prior to Incubation on Hatching Results. Eggs Laid January 21 to April 26, 1948; Turned Daily.

Days Held	High Humidity (82-87% R.H.)		Medium Humidity (58-64% R.H.)		Low Humidity (38-48% R.H.)	
	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs
1	131	75.6	130	67.7	127	70.8
2	115	78.3	115	74.8	116	81.0
3	120	67.5	120	72.5	121	75.2
4	122	74.6	123	68.3	124	78.2
5	115	74.8	118	72.0	117	71.8
6	123	74.8	121	69.4	117	75.2
7	122	70.5	123	76.4	123	76.4
8	121	74.4	117	70.9	115	72.2
9	120	71.7	122	68.0	125	68.0
10	126	77.7	128	66.4	125	68.8
11	123	75.6	125	72.0	128	77.3
12	117	73.5	122	68.0	122	75.4
13	126	61.9	121	67.8	126	75.4
14	103	71.8	106	76.4	104	76.9
Total	1684	73.0	1691	70.7	1690	74.4

# EFFECT OF HUMIDITY AND TURNING OF EGGS BEFORE INCUBATION ON HATCHING RESULTS

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## I. INTRODUCTION

Many conditions, which prevail after eggs are laid and before they are set, affect hatching. This publication reports the results of experiments designed to determine the influence of humidity and turning prior to incubation on subsequent hatching results.

North of the Wyoming Agricultural Experiment Station reported in 1941 that high relative humidity where hatching eggs were held was beneficial. He reported that eggs held for 10 days hatched about 4% better when high humidity was maintained.

Another direct experiment on humidity and its effect on hatchability was reported by Cooney of Oregon in 1943. None of the eggs were held at extremely low humidity and the temperatures were mostly within a safe range, but the higher humidity resulted in a substantially increased percentage of hatchability. Eggs held at a relative humidity of 66.1% hatched 70.8% and eggs held at a relative humidity of 88.9% hatched 74.7%.

More recent (1950) work at the Georgia Agricultural Experiment Station indicated that at 55°F. hatchability was the same for eggs held at relative humidities of 45, 55, 75 and 88%.

The fact that the investigations of North and Cooney were not conducted under well controlled temperature conditions and that relatively small numbers of eggs were involved suggested that more research was needed on this problem. The Georgia report was released after the investigations reported here were begun.

Jackson (1912), Waite (1919), Dougherty (1928) and Funk (1934) reported conflicting conclusions with respect to the turning of eggs being held for hatching purposes. However, their experiments were based upon inadequate numbers of eggs to justify valid conclusions.

## II. METHODS AND PROCEDURE

Eggs laid by a flock of 250 New Hampshire pullets from the University of Missouri flocks were used for this investigation. White Plymouth Rock eggs produced in early 1950 were also used to investigate one phase of turning.

In addition eggs were obtained from a hatchery supply flock of 3000 New Hampshire pullets mated to Delaware males.

The purebred New Hampshire eggs which were pedigreed were gathered four times daily and placed in a basement room until 4:30 P.M. when they were divided into six lots and held on filler-flats in 30-dozen wooden cases in three refrigerated coolers. From January 21 to August 2, 1948, half the eggs in each cooler were turned once daily by tilting the egg case. Eggs were held 1-14 days during this period. From October 7, 1948 to February 16, 1949 eggs were held 0-13 days and none were turned. An average temperature of 55°F. was maintained in each cooler. Relative humidities of approximately 40%, 60% and 80% were maintained. The relative humidity was recorded by recording hygrometers. The range in relative humidity is shown in the tables. Calcium chloride was used to keep the humidity low in the 40% relative humidity section. It was also necessary to use some calcium chloride during the summer months to hold the 60% relative humidity. An automatic humidifier was used in the cooler where high relative humidity was desired. It maintained the relative humidity within a range of 80% to 88%.

During the period from January 21 to August 2, 1948 the eggs were set at two-week intervals in a forced-draft incubator operated at a dry bulb temperature of  $99\frac{3}{4}$ °F. with a wet bulb reading of approximately 86°F. Of the eggs set from October 7, 1948 to February 16, 1949 one half were incubated at a wet bulb reading of 80°F. and the others at a wet bulb reading of 86°F.

During the period January 29 to March 26, 1950 two cases of hatching eggs of each day's production were obtained from a local commercial hatchery supply flock of New Hampshire pullets mated to Delaware males. These eggs were divided into three lots and held at low, medium and high humidity for 1 to 7 days.

On the 18th day of incubation the eggs were candled and the clear eggs and dead embryos removed. All clear eggs were broken and examined to determine if there had been any embryonic development during incubation. The remaining eggs were transferred to a separate hatcher operated at 99°F. and a wet bulb reading of 90°F.

### III. DISCUSSION OF RESULTS

#### A. The Effect of Humidity Before Incubation on the Hatching of Chicken Eggs

1. The Effect of High, Medium and Low Humidity During the Holding Period on Hatchability of Eggs Held at 55°F.—Tables 1 to 6 inclusive show the hatching results obtained from January 21 to April 26, 1948 and from April 27 to August 2, 1948. (For Table 1 see page 2.)

Table 1 shows the percentage of hatch of all eggs set of turned eggs held at the three humidity levels during the spring period. Eggs (1690) held at low humidity hatched 74.4%, 1691 eggs held at medium humidity hatched 70.7%,

Table 2.--Effect of Humidity Prior to Incubation on Hatching Results. Eggs Laid January 21 to April 26, 1948; Not Turned.

Days Held	High Humidity (82-87% R.H.)		Medium Humidity (58-64% R.H.)		Low Humidity (38-48% R.H.)	
	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs
1	129	75.2	125	74.4	125	77.6
2	114	77.2	118	78.8	118	81.4
3	118	77.1	119	67.2	119	73.9
4	122	71.3	124	74.2	123	77.2
5	115	71.3	115	73.9	114	71.1
6	124	71.8	121	74.4	117	68.4
7	121	71.1	119	77.3	119	70.6
8	118	75.4	118	64.4	116	75.9
9	120	66.7	125	73.6	124	70.2
10	127	67.7	127	74.8	125	68.8
11	124	68.5	124	72.6	125	59.5
12	118	68.6	121	62.0	124	64.5
13	122	59.8	124	59.7	126	71.4
14	102	59.8	104	72.1	102	61.8
Total	1674	70.2	1684	71.4	1678	70.9

Table 3.--Effect of Humidity Prior to Incubation on the Percentage of Hatch of Eggs Set. Eggs Laid April 27 to August 2, 1948; Turned Daily. Number of Eggs Per Lot Varied From 90 to 118 With a Total of 4595 Eggs.

Days Held	High Humidity (80-88% R.H.)	Medium Humidity (62-70% R.H.)	Low Humidity (42-50% R.H.)
1	73.3	74.8	72.3
2	68.8	70.6	59.4
3	71.8	69.9	68.5
4	73.3	73.2	67.9
5	67.6	76.6	72.7
6	70.9	67.8	69.2
7	70.5	70.8	71.6
8	73.9	68.6	68.1
9	58.4	72.3	68.9
10	66.4	73.5	63.0
11	70.5	66.0	64.9
12	67.7	51.9	57.4
13	63.2	68.2	56.9
14	73.5	64.0	64.0
1 - 14	69.4	69.2	66.0
Total Eggs	1521	1544	1530

and 1,684 eggs held at high humidity hatched 73.0%. Table 2 shows hatching results of unturned eggs held under the same conditions as the turned eggs. Eggs (1678) held at low humidity hatched 70.9%, while 1684 eggs held at medium humidity hatched 71.4% and 1674 eggs held at high humidity hatched 70.2% of all eggs set. These results indicated that for this period and under the conditions which prevailed the humidity of the air surrounding the eggs before incubation did not consistently affect hatching results.

Table 3 shows the effect on hatching results of holding humidity with turned eggs during the period April 27 to August 2, 1948. Eggs held at low humidity hatched 66.0%. Those held at medium humidity hatched 69.2% and eggs held at high humidity hatched 69.4%. There were 1530, 1544 and 1521 eggs in the respective lots.

Table 4 shows the effect of holding humidity on unturned eggs during the same period. Eggs held at low humidity hatched 66.6%. Eggs held at medium humidity hatched 65.1% and eggs held at high humidity hatched 70.0%. The number of eggs in each lot ranged from 1528 to 1539 eggs.

Table 4.--Effect of Humidity Prior to Incubation on the Percentage of Hatch of Eggs Set. Eggs Laid April 27 to August 2, 1948; Not Turned. Number of Eggs Per Lot Varied From 99 to 120 With a Total of 4600 Eggs.

Days Held	High Humidity (80-88% R.H.)	Medium Humidity (62-70% R.H.)	Low Humidity (42-50% R.H.)
1	63.1	77.0	71.3
2	74.8	66.1	70.5
3	73.6	73.0	62.4
4	79.3	52.8	70.9
5	84.6	72.2	79.6
6	76.5	69.9	73.5
7	67.9	67.2	75.2
8	70.7	67.5	69.6
9	74.3	68.3	56.6
10	66.4	68.5	61.1
11	65.1	61.1	58.4
12	60.8	55.7	64.8
13	65.4	62.6	58.8
14	57.5	50.0	60.2
1 - 14	70.0	65.1	66.6
<b>Total Eggs</b>	<b>1539</b>	<b>1533</b>	<b>1528</b>

Table 5.--Effect of Humidity Prior to Incubation on Hatching Results. Eggs Laid January 21 to August 2, 1948; Turned Daily.

Days Held	High Humidity (80-88% R.H.)		Medium Humidity (58-70% R.H.)		Low Humidity (38-50% R.H.)	
	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs
1	232	74.6	233	70.8	228	71.5
2	224	73.7	224	72.8	222	70.7
3	230	69.6	233	71.2	232	72.0
4	227	74.0	231	70.6	230	73.5
5	223	71.3	229	74.2	227	72.3
6	240	72.9	239	68.6	234	72.2
7	234	70.5	236	73.7	239	74.1
8	236	74.2	235	69.8	228	70.2
9	221	65.6	223	70.0	215	68.4
10	239	72.4	245	69.8	233	66.1
11	228	73.2	231	69.3	242	71.5
12	219	70.8	228	60.5	230	67.0
13	232	62.5	228	68.0	242	66.5
14	220	72.7	220	70.0	218	70.2
<b>Total</b>	<b>3205</b>	<b>71.3</b>	<b>3235</b>	<b>69.9</b>	<b>3220</b>	<b>70.4</b>

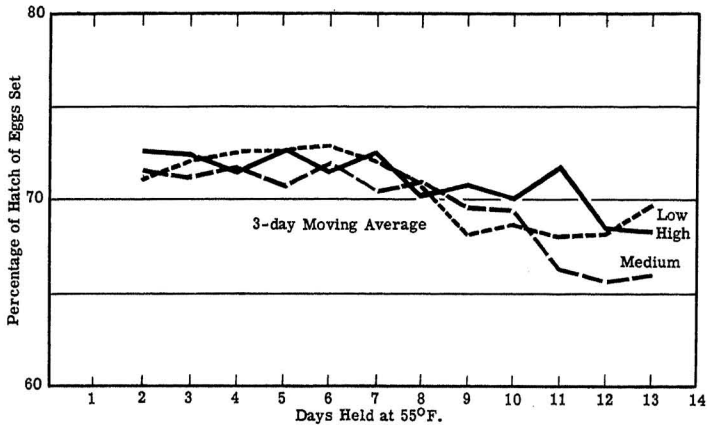


Figure 1. Effect of humidity prior to incubation on hatching results with eggs laid January 21 to August 2, 1948, and turned daily.

Table 6.--Effect of Humidity Prior to Incubation on Hatching Results. Eggs Laid January 21 to August 2, 1948; Not Turned.

Days Held	High Humidity (80-88% R.H.)		Medium Humidity (58-70% R.H.)		Low Humidity (38-50% R.H.)	
	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs
1	232	69.8	225	75.6	226	74.8
2	225	76.0	227	72.7	223	76.2
3	228	75.4	230	70.0	228	68.4
4	228	75.0	230	63.0	226	74.3
5	225	77.8	223	73.1	222	75.2
6	243	74.1	241	72.2	234	70.9
7	233	69.5	235	72.3	232	72.8
8	234	73.1	232	66.0	228	72.8
9	221	70.1	226	71.2	223	64.1
10	243	67.1	238	71.9	238	65.1
11	230	67.0	232	67.2	239	59.0
12	223	65.0	227	59.0	232	64.7
13	226	62.4	231	61.0	240	65.4
14	222	58.6	220	60.5	215	60.9
Total	3213	70.1	3217	68.3	3206	68.9

These results indicate the importance of holding eggs at high humidity during the summer months when shell quality is generally lower.

Table 5 shows the effect of humidity on the hatching of turned eggs for the entire period of January 21 to August 2, 1948. The number of eggs involved in each lot was slightly over 3200. The eggs held at low humidity during this period hatched 70.4%. The eggs held at medium humidity hatched 69.9% and the eggs held at high humidity hatched 71.3%. Figure 1 shows the

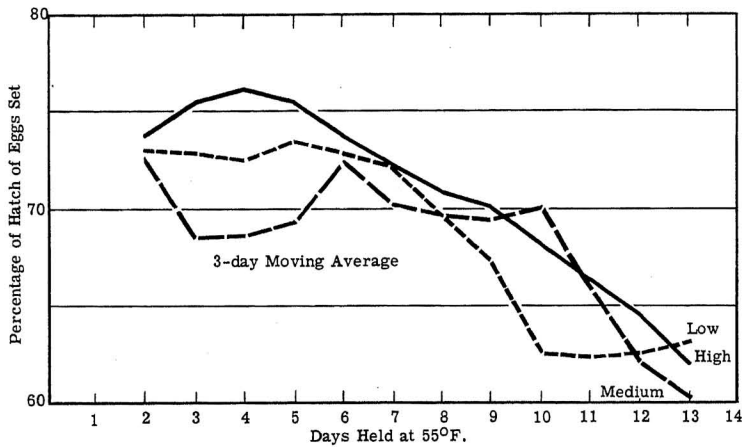


Figure 2. Effect of humidity prior to incubation on hatching results with eggs laid January 21 to August 2, 1948, but not turned.

Table 7.--Summary of Hatching Results With Eggs Held at 55°F. and Low Relative Humidity (38-50% R.H.). January 21, 1948, to February 16, 1949. Figures in Table are Percentages Except for Eggs Set.

Days Held	Eggs Set	Infertile	Dead Before Blood Formed	Dead 2-18 Days	Dead in Shell	Hatch of All Eggs	Hatch of Fertile Eggs
0	357	6.7	1.4	7.0	10.9	74.0	79.3
1	811	6.3	1.6	9.3	10.5	72.4	77.2
2	789	6.0	2.0	9.6	9.3	73.1	77.8
3	824	7.2	9.2	9.6	10.8	72.2	77.4
4	826	5.5	1.8	8.5	9.7	74.6	78.9
5	810	4.1	2.2	8.8	10.6	74.3	77.5
6	832	5.3	1.4	10.0	13.0	70.3	74.2
7	826	6.5	1.5	10.1	10.4	71.6	76.6
8	799	7.3	.75	9.5	10.5	72.0	77.6
9	797	4.4	2.1	10.8	15.1	67.6	70.7
10	832	5.8	.60	10.6	14.9	68.2	72.3
11	782	5.2	1.9	12.7	12.2	68.0	71.8
12	760	7.0	2.0	12.1	14.1	64.9	69.7
13	773	7.6	.84	13.8	14.7	63.7	68.9
14	433	5.5	1.6	12.9	14.3	65.6	69.4
Total	11251	6.0	1.6	10.3	11.9	70.2	74.7

percentage hatch of all turned eggs for each of the three humidities based on 3-day moving averages. Table 6 shows the effect of humidity on unturned eggs held under the same conditions during the same period. Eggs (3206) held at low humidity hatched 68.9%, 3,217 eggs held at medium humidity hatched 68.3% and 3,206 eggs held at high humidity hatched 70.1%. Figure 2 shows the percentage of hatch for all unturned eggs held at each of the three humidities during the same period.

The effect of humidity on eggs held at 55°F. is summarized in Tables 7, 8 and 9. Table 7 shows the hatching results of 11,251 eggs held at low humidity during the January 21 to August 2 and October 7, 1948 to February



Table 8.--Summary of Hatching Results With Eggs Held Where the Relative Humidity was Medium (56-70% R.H.) and the Temperature was 55°F. January 21, 1948, to February 16, 1949. Figures in Table are Percentages Except for Eggs Set.

Days Held	Eggs Set	Infertile	Dead Before Blood Formed	Dead 2-18 Days	Dead in Shell	Hatch of All Eggs	Hatch of Fertile Eggs
0	354	6.2	.85	7.9	7.9	77.1	82.2
1	811	5.8	1.2	9.4	9.9	73.7	78.3
2	794	7.7	.76	7.8	8.6	75.2	79.0
3	830	7.6	1.2	8.7	9.6	72.9	78.9
4	829	6.6	2.5	11.1	11.1	68.6	73.5
5	809	5.8	.87	10.9	9.8	72.7	77.2
6	841	6.8	.95	10.3	10.8	71.1	75.3
7	828	7.4	1.8	8.9	10.1	71.7	77.4
8	814	4.9	1.6	10.6	12.4	70.5	74.2
9	806	5.7	1.6	11.0	10.7	71.0	77.3
10	840	5.5	1.7	9.2	13.0	70.7	74.8
11	767	6.7	1.4	10.8	14.5	66.6	71.4
12	759	6.9	2.2	12.4	16.3	62.2	66.8
13	748	6.0	2.4	11.9	14.3	65.4	69.6
14	440	6.4	1.8	11.8	14.8	65.2	69.7
Total	11270	6.4	1.5	10.2	11.6	70.3	75.1

Table 9.--Summary of Hatching Results With Eggs Held at 55°F. and High Relative Humidity (80-88% R.H.). January 21, 1948, to February 16, 1949. Figures in Table are Percentages Except for Eggs Set.

Days Held	Eggs Set	Infertile	Dead Before Blood Formed	Dead 2-18 Days	Dead in Shell	Hatch of All Eggs	Hatch of Fertile Eggs
0	345	9.0	.3	8.4	7.3	75.1	82.5
1	818	6.5	2.1	7.3	9.5	74.4	79.7
2	791	6.7	1.6	7.7	8.9	75.1	80.5
3	821	5.1	1.2	9.1	11.1	73.5	77.4
4	825	5.2	1.9	9.0	8.6	75.3	79.4
5	797	5.8	1.1	7.2	10.3	75.7	80.3
6	846	5.3	2.1	8.9	10.2	73.5	77.7
7	824	6.2	1.7	8.7	12.9	70.5	75.2
8	825	5.5	1.2	8.9	10.3	74.2	78.5
9	798	5.8	1.8	8.3	15.4	68.8	73.0
10	845	7.2	2.6	6.4	12.4	71.4	76.9
11	761	7.4	1.5	8.9	11.8	70.4	76.0
12	745	6.2	1.6	9.0	14.5	68.7	73.3
13	746	6.0	2.7	11.8	15.3	64.2	68.3
14	442	3.6	1.1	12.2	17.4	65.6	68.1
Total	11229	6.1	1.7	8.7	11.7	71.9	76.5

16, 1949 periods. These eggs averaged 70.2% hatch of all eggs set. Table 8 shows that 11,270 eggs held at medium humidity hatched 70.3 and Table 9 shows that 11,229 eggs held at high humidity hatched 71.9%. Figure 3 shows the 3-day moving average percentage of hatch of all eggs held at 55°F. at each of the three humidities.

Although the difference in percentage of hatch in each of the individual hatches is not great there is some difference in favor of high holding humidity.

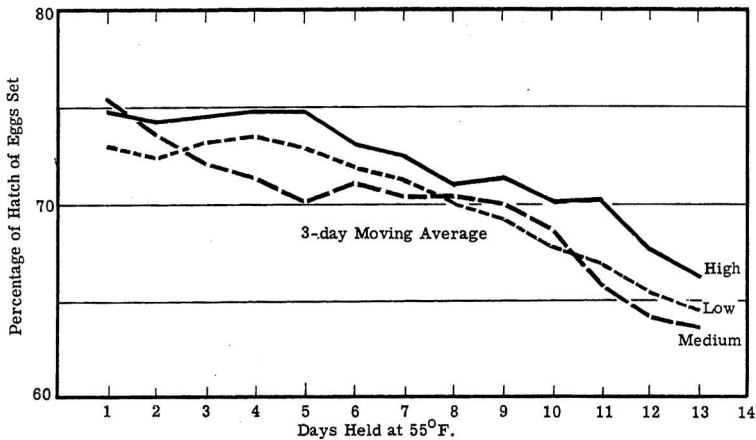


Figure 3. Effect of humidity on hatching results with eggs laid January 21, 1948, to February 16, 1949, and held at 55°F.

Table 10.--Effect of Humidity Prior to Incubation on Hatching Results With Eggs Held at 70°F. Eggs Laid March 17 to 31, 1949; Not Turned.

Days Held	High Humidity (80-88% R.H.)		Medium Humidity (58-62% R.H.)		Low Humidity (34-38% R.H.)	
	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs
0	85	73.7	85	73.7	85	73.7
1	86	73.3	85	74.1	85	71.8
2	81	75.3	81	74.1	81	75.3
3	82	75.6	83	67.5	82	63.4
4	84	73.8	84	73.8	85	64.7
5	93	76.3	94	74.5	95	61.1
6	82	68.3	87	69.0	85	63.5
7	85	70.6	78	62.8	78	59.0
8	86	67.4	88	68.2	88	60.2
9	89	65.2	86	68.6	85	55.3
10	87	59.8	95	59.0	96	67.7
11	82	68.9	82	58.5	84	63.1
12	90	58.9	87	59.8	87	42.5
13	93	68.8	93	61.3	92	65.2
Total	1205	69.3	1208	67.0	1208	62.5

This difference in percentage of hatch is the result of fewer embryos dying from 2 to 18 days of the incubation period. There was little difference in the percentage of eggs failing to initiate development, dead before blood formed or of those dead in the shell.

2. Effect of Humidity on Hatching at Other Holding Temperatures.— Since the moisture carrying capacity of air is greatly increased as temperature is increased, it was deemed advisable to study the effect of holding humidity on eggs held at higher temperatures.

New Hampshire eggs (3621) laid March 17 to March 31, 1949 were divided into three groups and held 0-13 days at low, medium and high humidity and at 70°F. See Table 10. The eggs held at low humidity hatched 62.5%.

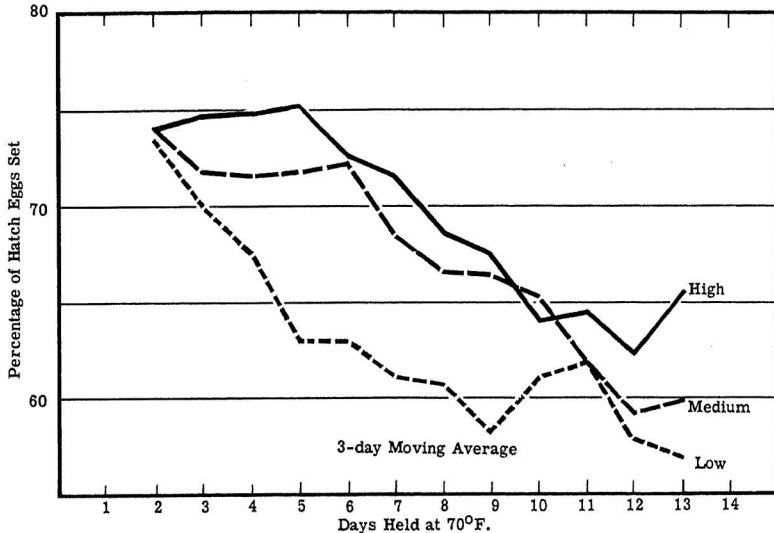


Figure 4. Effect of humidity prior to incubation on hatching results with New Hampshire eggs held at 70°F.

Table 11.--A Summary of the Effect of Humidity Prior to Incubation on the Percentage of Hatch of Eggs Held at 55°F. and 70°F.

Period	Treatment	Held 0-7 Days			Held 8-14 Days			Total Eggs in Six Lots
		High	Medium	Low	High	Medium	Low	
1/21 to 4/27/48	Held at 55°F. Turned	74.6	72.4	76.4	73.2	70.7	74.2	5065
1/21 to 4/27/48	Not Turned	74.4	75.1	75.1	67.4	69.2	68.2	5036
4/27 to 8/2/48	Turned	70.9	71.6	68.8	67.7	66.4	63.3	4595
4/27 to 8/2/48	Not Turned	75.1	68.7	72.7	66.5	62.7	62.0	4600
10/2/48 to 2/16/49	Incubated at 86°F. Wet Bulb	76.3	77.2	74.0	72.9	71.0	68.7	7234
10/2/48 to 2/16/49	Incubated at 80°F. Wet Bulb	76.7	73.2	73.9	70.9	68.9	69.4	7220
3/17 to 3/31/48	Held at 70°F.	73.8	72.4	67.6	65.7	62.6	59.0	3621

Those held at medium humidity hatched 67.0% and those held at high humidity hatched 69.3%. There were approximately 1200 eggs in each lot. Figure 4 shows the plotted 3-day moving average hatch of the three humidity groups. High holding humidity maintained hatchability better throughout the holding period. A summary of the hatching results, showing the effect of humidity at 55°F. and 70°F. is presented in Table 11.

These results of a single test at 70°F. suggested that more information was needed on the effect of humidity and temperature on hatchability of eggs. Accordingly, during the period January 29 to March 26, 1950 two cases of hatching eggs of each day's production secured from a local commercial hatchery flock of New Hampshire pullets mated to Delaware cockerels were divided into three lots and held at low, medium and high humidity for 1 to 7 days.

Table 12.--Relation of Holding Temperatures and Humidity to Hatchability of Eggs Laid January 29 to March 26, 1950.

Days Held	50°F.								55°F.									
	80-90% R.H.		55-65% R.H.		35-45% R.H.		80-90% R.H.		55-65% R.H.		35-45% R.H.		80-90% R.H.		55-65% R.H.		35-45% R.H.	
	Eggs Set	% Hatch	Eggs Set	% Hatch	Eggs Set	% Hatch	Eggs Set	% Hatch	Eggs Set	% Hatch	Eggs Set	% Hatch	Eggs Set	% Hatch	Eggs Set	% Hatch	Eggs Set	% Hatch
1	475	78.1	471	78.3	466	75.3	478	76.8	477	76.9	477	76.9	477	76.9	477	76.9	477	76.9
2	474	74.9	478	79.5	461	77.7	471	79.0	470	76.8	471	77.3	471	77.3	471	77.3	471	77.3
3	474	80.2	476	75.8	477	82.0	477	76.1	475	76.4	475	75.6	475	75.6	475	75.6	475	75.6
4	474	78.9	470	76.2	474	74.5	477	79.7	474	74.7	477	78.2	477	78.2	477	78.2	477	78.2
5	475	76.4	476	80.7	473	79.3	472	76.1	473	81.2	476	80.3	476	80.3	476	80.3	476	80.3
6	469	76.3	478	78.2	475	73.9	475	75.4	474	76.4	469	76.3	469	76.3	469	76.3	469	76.3
7	459	77.1	477	75.1	474	77.2	476	73.9	477	76.1	474	75.3	474	75.3	474	75.3	474	75.3
Total	3300	77.4	3326	77.7	3299	77.1	3326	76.7	3320	76.9	3319	77.6	3319	77.6	3319	77.6	3319	77.6
Days Held	60°F.								70°F.									
1	475	69.1	474	77.2	473	71.7	473	76.3	471	73.0	473	75.7	473	75.7	473	75.7	473	75.7
2	473	72.9	475	76.6	451	74.3	475	72.4	472	80.7	471	72.0	471	72.0	471	72.0	471	72.0
3	473	72.3	474	79.3	475	76.0	474	72.4	474	77.8	472	77.6	472	77.6	472	77.6	472	77.6
4	475	75.2	471	74.3	476	78.8	474	77.8	477	76.3	477	75.0	477	75.0	477	75.0	477	75.0
5	477	79.2	478	75.3	477	73.2	471	73.5	471	73.9	466	78.5	466	78.5	466	78.5	466	78.5
6	475	74.3	475	74.9	475	74.5	464	73.5	472	73.9	464	69.2	464	69.2	464	69.2	464	69.2
7	475	78.5	473	70.4	479	72.0	472	71.4	473	71.9	479	72.9	479	72.9	479	72.9	479	72.9
Total	3323	74.5	3320	75.5	3306	74.3	3303	74.0	3310	75.4	3302	74.4	3302	74.4	3302	74.4	3302	74.4

Eggs set on February 5 and March 5 were held at 55°F. Eggs set on February 12 and March 12 were held at 50°F. Eggs set on February 19 and March 19 were held at 70°F. and eggs set on February 26 and March 26 were held at 60°F. The results of these tests are shown in Table 12. Eggs held at medium humidity and a temperature of 50°F. hatched 77.7%, while eggs held at low humidity hatched 77.1% and those held at high humidity hatched 77.4%. Eggs held at low humidity and 55°F. hatched 77.6% while those at medium humidity hatched 76.9% and those at high humidity hatched 76.7%. Eggs held at 60°F. and medium humidity hatched 75.5% while those held at high humidity hatched 74.5% and low humidity hatched 74.3%. Eggs held at 70°F. and medium humidity hatched 75.4% while those held at high and medium hatched 74.0% and 74.4% respectively.

None of these differences are statistically significant and therefore these results indicated that humidity during the holding period did not affect the hatchability of the Delaware x New Hampshire eggs held at 50°F., 55°F., 60°F., or 70°F. Since high humidity gave significantly better hatches with purebred New Hampshire eggs held at 70°F. (Table 11) than did low humidity, these data suggest strain or breed differences with respect to holding humidity. This difference may be an expression of hybrid vigor.

3. The Effect of Humidity on the Hatchability of Large, Medium and Small Eggs.—During the period September 20 to November 29, 1950 two cases of hatching eggs of the previous day's production were obtained from a local commercial hatchery supply flock of New Hampshire pullets mated to Delaware males. These eggs were divided into three weight classifications;

eggs above 26 ounces per dozen, 23 to 26 ounces per dozen, and eggs 20 to 23 ounces per dozen. Eggs in each weight group were divided into three lots and held 1 to 7 days at 50°F. and where relative humidities of 38-53%, 68-80%, and 83-90% prevailed. At setting time each of these nine lots were divided into three lots and incubated at relative humidities of 55-60%, 40-54% and 35-48% and at 99 $\frac{3}{4}$ °F. These eggs were all hatched together where the temperature was 99°F. and the wet bulb thermometer reading was 90°F. Clear eggs in this test were not broken to determine if there had been embryonic development during incubation.

During this period (September 20 to November 29, 1950) 37,878 eggs were used to study the effect of holding humidity and incubation humidity on hatchability of large, medium, and small hatching eggs. Results obtained (Table 13) confirm other studies which have established the fact that large hatching eggs do not hatch as well as medium and small eggs, and small eggs do not hatch as well as medium sized hatching eggs. Eggs (5829) classified as larger than 26 ounces per dozen hatched 67.9%, 19,278 eggs weighing 23 to 26 ounces per dozen hatched 70.4%, and 12,771 eggs in the 20 to 23 ounce per dozen classification hatched 69.7%.

The importance of proper incubation humidity is well established. Table 14 shows that 12,621 eggs in this test incubated at 55-60% relative humidity hatched 71.7%, 12,618 eggs incubated at 40-54% relative humidity hatched 69.2% and the 12,637 eggs incubated at 35-48% relative humidity hatched 68.4%. Embryonic death after the 18th day accounted for most of these differences. All these eggs were hatched in the same hatcher; operated with approximately 70% relative humidity.

Previous experiments at this station failed to show that holding humidity had much influence on the hatchability of eggs. Table 15 shows that in tests with eggs from a flock of Delaware x New Hampshires 12,637 eggs held at 83-90% relative humidity hatched 70.2% and the 12,651 eggs held

Table 13.--The Effect of Egg Size on the Hatchability of Eggs. Delaware x New Hampshire Eggs Laid September 20 to November 29, 1950.

Ounces per Dozen	No. Eggs	PERCENTAGE			
		Infertile	Dead 1-18 Days	Dead in Shell	Hatch All Eggs
26.1 oz. or larger	5,829	8.41	10.67	12.99	67.93
23.1 to 26.0 oz.	19,278	7.95	9.82	11.87	70.35
20 to 23 oz.	12,771	9.04	9.99	11.24	69.70

Table 14.--The Effect of Incubation Humidity on the Hatchability of Eggs. Delaware x New Hampshire Eggs Laid September 20 to November 29, 1950.

Percentage Relative Humidity	No. Eggs	PERCENTAGE			
		Infertile	Dead 1-18 Days	Dead in Shell	Hatch All Eggs
55-60	12,621	8.22	10.02	10.05	71.72
40-54	12,618	8.17	10.01	12.62	69.20
35-48	12,637	8.78	10.01	12.84	68.37

Table 15.--The Effect of Holding Humidity on the Hatchability of Eggs Held 1-7 Days. Delaware x New Hampshire Eggs Laid September 20 to November 29, 1950.

Percentage Relative Humidity	No. Eggs	PERCENTAGE			
		Infertile	Dead 1-18 Days	Dead in Shell	Hatch All Eggs
83-90	12,637	8.62	10.04	11.13	70.21
68-80	12,651	7.96	9.56	12.36	70.11
38-53	12,588	8.60	10.43	12.01	68.96

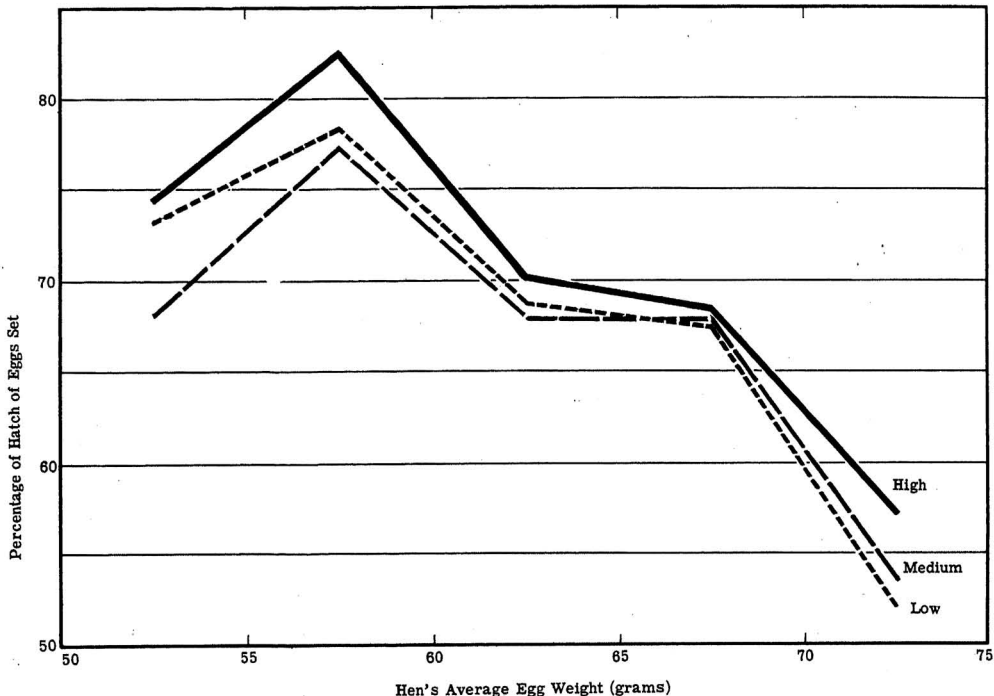


Figure 5. Effect of humidity prior to incubation on hatching results with eggs laid by hens that laid eggs of different sizes.

at 68-80% relative humidity hatched 70.1% The 12,588 eggs held at 38-53% relative humidity hatched 69.0%.

Hatching results obtained during the period January 21 to August 2, 1948 indicated that high holding humidity was more important in maintaining hatchability of small eggs than large eggs (Figure 5). Table 16 shows the effect of holding humidity on hatchability of large, medium and small hatching eggs which were produced September 20 to November 29, 1950. It will be noted that large eggs held at 83-90% relative humidity hatched 1.35% better than large eggs held at 38-53% relative humidity. Medium-sized eggs held at 83-90% relative humidity hatched 1.91% better than those held at

Table 16.--The Effect of Holding Humidity on the Hatchability of Large, Medium, and Small Eggs Held 1-7 Days. September 20 to November 29, 1950.

Egg Size Ounces Per Dozen	Percentage Relative Humidity	No. Eggs	PERCENTAGE			
			Infertile	Dead 1-18 Days	Dead in Shell	Hatch of All Eggs
above 26	83-90	1942	8.14	11.02	12.26	68.58
above 26	68-80	1946	7.76	11.15	13.10	67.99
above 26	38-53	1941	9.33	9.84	13.60	67.23
23.1-26	83-90	6445	8.16	10.02	10.80	71.02
23.1-26	68-80	6447	7.49	9.23	12.38	70.90
23.1-26	38-53	6386	8.21	10.23	12.45	69.11
20-23	83-90	4250	9.53	9.62	11.11	69.74
20-23	68-80	4258	8.76	9.35	12.00	69.89
20-23	38-53	4261	8.85	11.01	10.63	69.51

Table 17.--The Effect of Humidity During Incubation on the Hatchability of Large, Medium, and Small Eggs. September 20 to November 29, 1950.

Egg Size Ounces Per Dozen	Percentage Relative Humidity	No. Eggs	PERCENTAGE			
			Infertile	Dead 1-18 Days	Dead in Shell	Hatch of All Eggs
above 26	55-60	1942	8.44	9.99	10.56	71.01
above 26	40-54	1941	8.40	10.87	13.34	67.39
above 26	35-48	1946	8.38	11.15	15.06	65.42
23.1-26	55-60	6424	7.47	10.01	10.04	72.48
23.1-26	40-54	6424	7.92	9.71	12.81	69.55
23.1-26	35-48	6430	8.46	9.75	12.77	69.02
20-23	55-60	4255	9.24	10.04	9.82	70.90
20-23	40-54	4253	8.44	10.06	11.99	69.50
20-23	35-48	4261	9.46	9.88	11.92	68.74

38-53% relative humidity. Small eggs held at 83-90% relative humidity hatched only 0.23% better than those held at 38-53% relative humidity, but small eggs held at 68-80% relative humidity hatched 0.15% better than those held at 83-90% relative humidity. These results would seem to indicate that it is more important to have high humidity for larger eggs thus contradicting the results of 1948. However, in neither period are these data statistically significant.

Table 17 shows the effect of incubation humidity on hatchability of large, medium and small hatching eggs. Large eggs incubated at 55-60% relative humidity hatched 3.6% more chicks than large eggs incubated at 40-54% relative humidity and 5.59% more chicks than those incubated at 35-48% relative humidity. Medium eggs incubated at 55-60% relative humidity hatched 2.93% more chicks than medium eggs incubated at 40-54% relative humidity and 3.46% more chicks than medium eggs incubated at 35.48% relative humidity. The percentage hatch of small eggs incubated at 55-60% relative humidity was 1.40% higher than for small eggs incubated at 40-54% relative humidity and 2.16% higher than for small eggs incubated at 35-48% relative humidity. These results show the importance of high incubation humidity particularly for larger hatching eggs.

Table 18.--The Effect of Holding Humidity and Incubation Humidity on Hatchability of Large Hatching Eggs (26.1 ounces and larger). September 20 to November 29, 1950.

Holding Humidity (% R.H.)	Incubation Humidity (% R.H.)	No. Eggs	PERCENTAGE			
			Infertile	Dead 1-18 Days	Dead in Shell	Hatch of All Eggs
83-90	55-60	647	8.81	10.36	9.27	71.56
83-90	40-54	648	7.40	11.75	12.03	68.82
83-90	35-48	647	8.19	10.97	15.46	65.38
68-80	55-60	648	7.87	9.41	10.49	72.23
68-80	40-54	649	7.24	11.09	14.95	66.72
68-80	35-48	649	8.17	12.94	13.87	65.02
38-53	55-60	647	8.66	10.20	11.90	69.24
38-53	40-54	644	10.56	9.78	13.04	66.62
38-53	35-48	650	8.77	9.54	15.84	65.85
Total		5829	8.41	10.67	12.99	67.93

Table 19.--The Effect of Holding Humidity and Incubation Humidity on Hatchability of 23.1 to 26.0 Ounce Hatching Eggs. September 20 to November 29, 1950.

Holding Humidity (% R.H.)	Incubation Humidity (% R.H.)	No. Eggs	PERCENTAGE			
			Infertile	Dead 1-18 Days	Dead in Shell	Hatch of All Eggs
83-90	55-60	2147	7.69	10.57	9.47	72.78
83-90	40-54	2149	8.24	10.19	10.89	70.68
83-90	35-48	2149	8.56	9.31	12.05	70.08
68-80	55-60	2149	6.51	8.84	10.80	73.85
68-80	40-54	2147	7.50	9.73	13.51	69.26
68-80	35-48	2151	8.46	9.11	12.83	69.60
38-53	55-60	2128	8.22	10.62	9.87	71.29
38-53	40-54	2128	8.04	9.21	14.05	68.70
38-53	35-48	2130	8.36	10.85	13.43	67.36
Total		19278	7.95	9.82	11.87	70.35

Table 18 shows the effect of holding and incubation humidity on hatchability of large hatching eggs. Large eggs held at 68-80% relative humidity and incubated at 55-60% relative humidity hatched 72.23% and large eggs held at 83-90% relative humidity and incubated at 55-60% relative humidity hatched 71.56%. No other combination of holding and incubation humidities for large eggs gave hatches above 70%.

Table 19 shows the effect of holding humidity and incubation humidity on hatchability of medium sized eggs. Medium eggs held at 68-80% relative humidity and incubated at 55-60% relative humidity hatched 73.85% which is 1.07% higher than medium eggs held at 83-90% relative humidity, and 2.56% higher than medium eggs held at 38-53% relative humidity and incubated at 55-60% relative humidity. All combinations of medium-sized eggs held at 83-90% relative humidity hatched above 70%. Medium-sized eggs held at relative humidities of 68-80% and 38-53% hatched above 70% only when incubated at 55-60% relative humidity.

Table 20 shows the effect of holding humidity and incubation on hatchability of small eggs. Small eggs held at 68-80% relative humidity and in-



Table 20.--The Effect of Holding Humidity and Incubation Humidity on Hatchability of 20 to 23 Ounce Hatching Eggs. September 20 to November 29, 1950.

Holding Humidity (% R.H.)	Incubation Humidity (% R.H.)	No. Eggs	PERCENTAGE			
			Infertile	Dead 1-18 Days	Dead in Shell	Hatch of All Eggs
83-90	55-60	1416	10.31	9.25	9.18	71.26
83-90	40-54	1416	8.97	9.89	12.29	68.85
83-90	35-48	1420	9.31	9.73	11.85	69.11
68-80	55-60	1418	9.17	8.96	10.37	71.50
68-80	40-54	1419	8.32	9.58	12.33	69.77
68-80	35-48	1421	8.80	9.50	13.30	68.40
38-53	55-60	1421	8.23	11.89	9.92	69.95
38-53	40-54	1418	8.04	10.72	11.35	69.89
38-53	35-48	1422	10.27	10.41	10.62	68.71
	Total	12771	9.04	9.99	11.24	69.70

Table 21.--Effect of Humidity Prior to Incubation on the Quality of Chicks Hatched.

Relative Humidity	No. Chicks	Saleable	Seconds	Crippled
Low (38-50% R.H.)	7899	96.6	1.9	1.6
Medium (56-70% R.H.)	7944	96.9	1.6	1.5
High (80-88% R.H.)	8073	96.9	2.0	1.1

cubated at 55-60% relative humidity hatched 71.50% which is 0.24% higher than for small eggs held at 83-90% relative humidity and incubated at 55-60% relative humidity. No other combination of holding and incubation humidities on small eggs gave hatches above 70%.

The results of this experiment indicated that a holding humidity of 68-80% or 83-90% and an incubation humidity of 55-60% were satisfactory combinations for obtaining maximum hatchability from eggs of all sizes.

#### 4. The Effect of Holding Humidity on the Quality of Chicks Hatched.—

The effect of humidity prior to incubation on the quality of chicks hatched is shown in Table 21. It will be noted that the holding humidity prior to incubation had little effect on the percentage of saleable chicks. Eggs held at high humidity tended to hatch sooner than those held at lower humidities and appeared to be of higher quality at the time they were removed from the hatcher. However, there was little noticeable difference at the end of the hardening period.

#### 5. The Effect of Holding Humidity on the Hatchability of Eggs Classified as to Evaporation.—

All eggs used in the humidity tests at 55°F. were pedigreed and the hatching record of each hen's eggs held in the three humidities was kept. On three successive days of each 14-day holding period the eggs placed in the low humidity compartment were weighed on an analytical balance to the nearest milligram. After ten days of holding the eggs were weighed back and the average percentage of daily evaporation recorded. This made it possible to classify the hens as to rate of evaporation of their eggs.

Figure 6 shows the effect of holding humidity upon hatchability of eggs

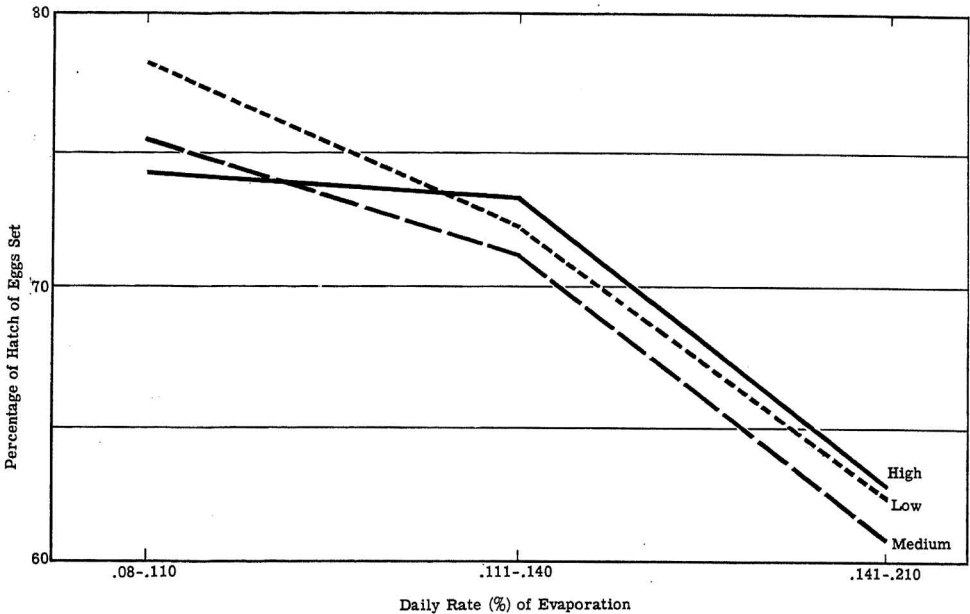


Figure 6. Effect of humidity prior to incubation on hatching results with eggs laid by hens that showed different rates of evaporation.

Table 22.--The Effect of Holding Humidity on Hatchability of Dark Brown, Medium Brown, and Light Brown New Hampshire Hatching Eggs Laid January 21 to August 2, 1948.

Percentage Relative Humidity	Dark Brown Eggs		Medium Brown Eggs		Light Brown Eggs	
	No. Eggs	% Hatch All Eggs	No. Eggs	% Hatch All Eggs	No. Eggs	% Hatch All Eggs
80-88	1622	77.25	4258	69.77	321	57.94
60-70	1677	76.03	4242	66.90	368	60.60
40-50	1689	75.31	4203	69.19	40.1	53.12

from hens classified as to their rate of daily evaporation. It will be noted that lower holding humidity resulted in a higher percentage of hatch for eggs having a low rate of evaporation, but high humidity gave best results for eggs having a high rate of evaporation.

This would appear to explain the difference in the effect of humidity on spring and summer eggs as observed in 1948 when high humidity improved the hatchability of summer eggs but not that of spring eggs; summer eggs in warm climates being noted for thinner shells.

6. The Effect of Holding Humidity on the Hatchability of New Hampshire Eggs of Different Color.—All eggs used in the humidity study during the January 21 to August 2, 1948 period were classified as to shell color. Table 22 shows the effect of holding humidity on hatchability of eggs in the three color groups during that period.

Table 23.--Effect of Humidity Prior to Incubation on Hatching Results of Washed Eggs. Eggs Laid January 21 to August 2, 1948.

Treatment	HOLDING HUMIDITY					
	High (80-88% R.H.)		Medium (60-70% R.H.)		Low (40-50% R.H.)	
	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs
Clean Eggs	6021	70.52	6039	69.10	6011	67.55
Washed	397	73.29	413	69.49	415	63.13

Dark brown eggs held at high humidity hatched better than those held at medium humidity, and those held at medium humidity hatched better than those held at low humidity.

Medium brown eggs did not respond to holding humidity as dark brown eggs did. Medium brown eggs held at high and low humidities hatched equally well while those held at medium humidity hatched the poorest.

Light brown eggs held at medium humidity hatched better than light brown eggs held at high humidity and those held at high humidity hatched better than those held at low humidity. Low humidity resulted in significantly lower hatches of light brown eggs.

**7. The Effect of Holding Humidity on the Hatchability of Washed Soiled Eggs.**—During the period January 21 to August 2, 1948 all soiled hatching eggs produced by the purebred New Hampshires were washed the day laid, divided into three groups and held 1 to 14 days at 55°F. and either at low, medium or high humidity. The soiled eggs were placed in a quaternary ammonium solution at room temperature and washed with a cloth. Table 23 shows the hatching results of those eggs. Soiled eggs washed and held at high humidity hatched 3.8% more chicks than those held at medium humidity and those held at medium humidity hatched 6.36% more chicks than those held at low humidity. These results also indicated that soiled hatching eggs may be washed with a disinfecting solution the day laid and held at high humidity during the holding period without reducing the hatchability below that expected for clean eggs. No exploding eggs or mushy chicks were encountered.

**8. The Relation of Humidity During the Holding and Incubation Period.**—From October 7, 1948 to February 16, 1949 the eggs held at low, medium and high humidity were each divided into two lots and incubated at relative humidities of approximately 58% and 40% respectively. All eggs were hatched with a dry bulb temperature of 99°F. and a wet bulb temperature of 90°F. The effect of holding humidity on hatchability of eggs incubated at a relative humidity of 58% is shown by Table 24. Eggs held before incubation at low humidity hatched 70.8% of 2,417 eggs, while 2,410 eggs held at medium humidity hatched 73.4% and 2,407 eggs held at high humidity hatched 73.9%.

Table 25 shows the effect of holding humidity on hatchability of eggs incubated at 40% relative humidity. Those held at low humidity hatched 71.1% of 2,408 eggs, while 2,408 eggs held at medium humidity hatched 70.4% and eggs held at high humidity hatched 73.1% of 2,404 eggs.

Table 24.--Effect of Humidity Prior to Incubation on Hatching Results of Eggs Incubated With a Relative Humidity of 58 Percent (86°F. wet bulb). Eggs Laid October 7, 1948, to February 16, 1949.

Days Held	High Humidity (80-88% R.H.)		Medium Humidity (56-68% R.H.)		Low Humidity (40-48% R.H.)	
	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs
0	173	78.6	177	73.5	179	76.0
1	177	72.9	177	76.9	179	69.3
2	171	78.4	172	80.8	173	75.1
3	183	73.2	184	74.5	183	74.3
4	186	73.1	184	75.0	185	70.3
5	173	76.3	179	74.9	181	77.4
6	184	75.5	181	78.5	182	69.8
7	177	75.7	177	70.1	178	67.4
8	177	74.6	174	71.3	172	69.2
9	177	70.6	179	70.4	180	71.1
10	182	73.6	179	76.0	180	73.9
11	152	67.8	151	64.9	151	73.5
12	151	70.9	151	70.9	149	61.7
13	144	71.5	145	67.6	145	58.6
Total	2407	73.9	2410	73.4	2417	70.8

Table 25.--Effect of Humidity Prior to Incubation on Hatching Results of Eggs Incubated With a Relative Humidity of 40 Percent (86°F. wet bulb). Eggs Laid October 7, 1948, to February 16, 1949.

Days Held	High Humidity (80-88% R.H.)		Medium Humidity (56-68% R.H.)		Low Humidity (40-48% R.H.)	
	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs	Eggs Set	Percentage Hatch of All Eggs
0	172	71.5	177	80.8	178	71.9
1	177	81.9	176	72.2	178	73.6
2	171	72.5	171	76.0	171	70.2
3	180	76.1	183	77.1	181	75.1
4	184	79.4	184	66.9	185	80.5
5	176	77.8	178	68.0	180	72.8
6	179	71.5	180	65.6	182	67.6
7	180	66.7	180	70.0	177	70.6
8	178	75.3	173	76.9	171	76.0
9	179	69.3	178	72.5	179	67.6
10	181	73.5	178	65.2	181	69.1
11	151	74.2	153	63.4	150	71.3
12	152	69.1	153	62.7	149	65.1
13	144	62.5	144	66.0	146	61.0
Total	2404	73.1	2408	70.4	2408	71.1

The hatch of all eggs (7234) incubated at a relative humidity of 58% was 72.7% and of 7,220 eggs incubated at a relative humidity of 40% the hatch was 71.5%, thus indicating the advisability of using higher incubation humidity.

Figure 7 shows the plotted 3-day moving average of the hatch of eggs held at the three humidity levels and incubated at a relative humidity of 58%. Figure 8 shows the plotted 3-day moving average of the hatch of the eggs held at the three humidity levels and incubated at a relative humidity of 40%.

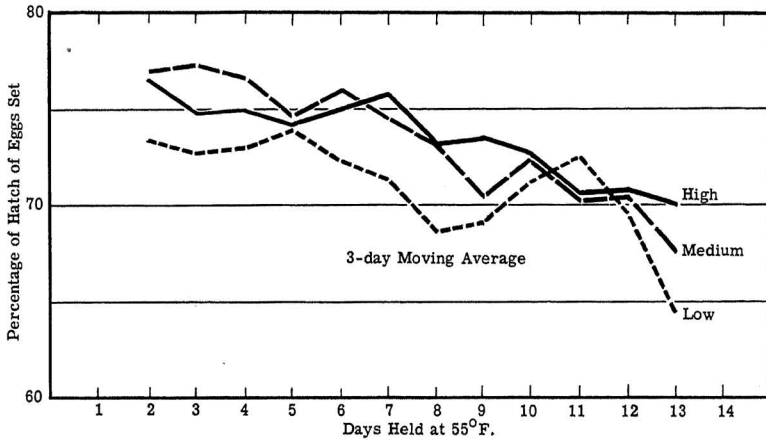


Figure 7. Effect of humidity prior to incubation on hatching results with eggs laid October 7, 1948, to February 16, 1949, which were incubated at a wet bulb temperature of 86°F. and a dry bulb temperature of 99¾°F.

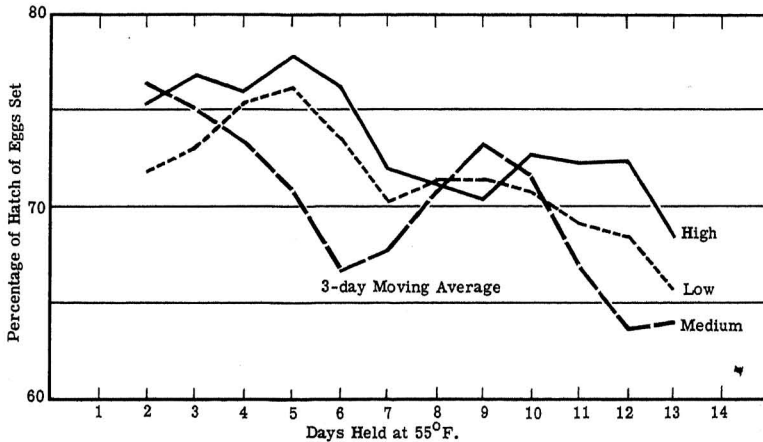


Figure 8. Effect of humidity prior to incubation on hatching results with eggs laid October 7, 1948, to February 16, 1949, which were incubated at a wet bulb temperature of 80°F.

#### B. The Effect of Turning Eggs Before Incubation on Hatching Results

The effect on hatching results of turning eggs held 1 to 14 days before incubation is shown in Tables 26 and 27 and Figures 9 and 10.

The results showed that turning hatching eggs held from 1 to 7 days did not improve hatching results and confirmed the opinions of Jackson, Waite and Funk that eggs held for less than one week before being set should not be turned. If there are any differences they are in favor of the eggs left unturned. Funk (1934) reported 9 out of 10 hatches in which unturned eggs held from 1 to 7 days hatched better than eggs turned.

The following data leave no doubt that daily (1-14 days) turning improved the hatchability of eggs held 11-14 days at high, medium and low humidity:

	Turned		Not Turned	
	No. eggs	Percentage of hatch	No. eggs	Percentage of hatch
High	899	69.7	901	62.6
Medium	907	66.9	910	62.0
Low	932	68.8	926	62.5

Table 26.--Effect of Turning Eggs Before Incubation on Hatching Results (Percentage). New Hampshire Eggs Laid January 21 to April 26, 1948, and Held at 55°F. Total of 10,101 Eggs, With 308 to 388 Eggs per Lot.

Time Held in Days	Dead 2-18 Days		Dead in Shell		Hatch of All Eggs Set	
	Turned	Not Turned	Turned	Not Turned	Turned	Not Turned
1	13.2	10.3	10.8	9.2	71.4	75.7
2	8.4	8.0	8.4	8.0	78.0	79.1
3	10.5	11.2	12.5	11.0	71.7	72.8
4	11.4	11.6	9.7	11.1	73.7	74.3
5	13.7	12.8	10.9	9.6	72.9	72.1
6	10.8	9.1	12.8	15.2	73.1	71.5
7	9.5	10.6	10.6	12.5	74.5	73.0
8	12.2	12.2	11.9	12.8	72.5	71.9
9	12.8	9.8	12.8	16.5	69.2	70.2
10	8.2	10.3	16.4	14.5	71.0	70.4
11	10.1	15.0	12.5	12.4	75.0	68.8
12	9.4	13.2	14.7	14.6	72.3	65.0
13	11.8	16.1	13.4	15.9	68.4	63.7
14	7.3	14.9	15.4	16.6	75.1	64.6
1 - 14	10.7	11.8	12.3	12.8	72.7	70.8
1 - 7					73.6	74.1
8 - 14					71.9	67.5

Table 27.--The Effect of Turning Eggs on Hatching Results (Percentage). New Hampshire Eggs Laid April 27 to August 2, 1948. Held 1-14 Days at 55°F. A Total of 9,195 Eggs, With 292 to 356 Eggs per Lot.

Time Held in Days	Dead 2-18 Days		Dead in Shell		Hatch of All Eggs	
	Turned	Not Turned	Turned	Not Turned	Turned	Not Turned
1	6.2	8.6	5.9	11.2	73.4	70.4
2	9.6	10.8	12.0	7.4	66.4	70.5
3	8.4	10.9	10.8	8.2	70.1	69.7
4	8.2	10.2	9.1	9.5	71.5	66.7
5	7.9	6.4	11.6	8.3	72.3	78.8
6	11.1	7.9	9.9	8.1	69.3	73.3
7	7.9	10.0	10.6	9.7	71.0	70.1
8	9.0	10.8	9.8	9.6	70.2	69.3
9	9.2	13.3	12.7	13.3	66.4	66.4
10	10.1	11.8	12.1	11.8	67.8	65.3
11	10.8	15.3	12.3	13.5	67.1	61.5
12	10.8	17.2	15.5	12.5	58.9	60.5
13	12.8	13.5	12.5	13.2	62.6	62.2
14	7.5	18.3	14.8	15.5	67.2	55.9
1 - 14	9.2	11.8	11.4	10.8	68.2	67.2
1 - 7					70.6	71.4
8 - 14					65.7	63.0

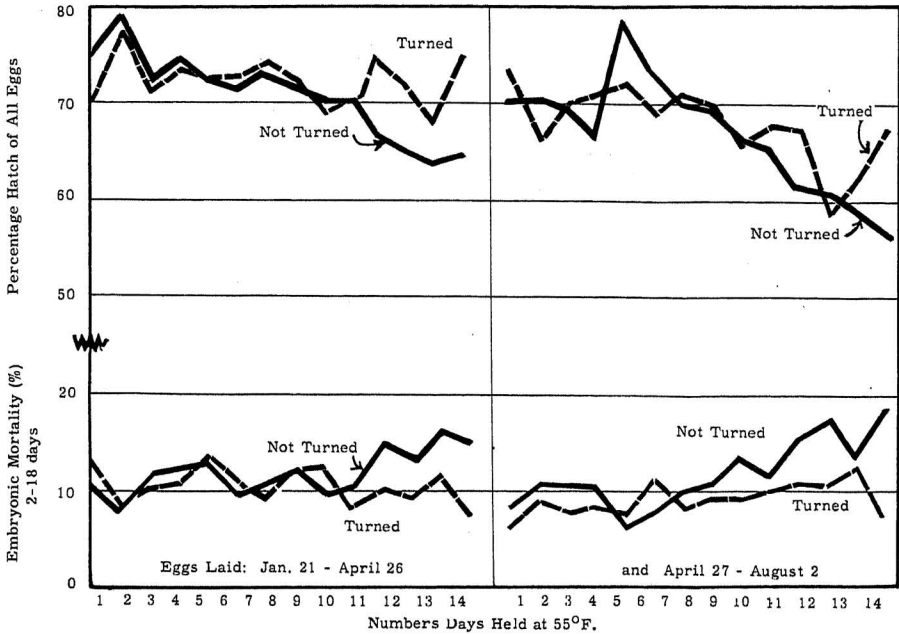


Figure 9. The effect of turning chicken eggs held for 1 - 14 days at 55°F. on embryonic mortality (2-18 days) and hatching results, 1948.

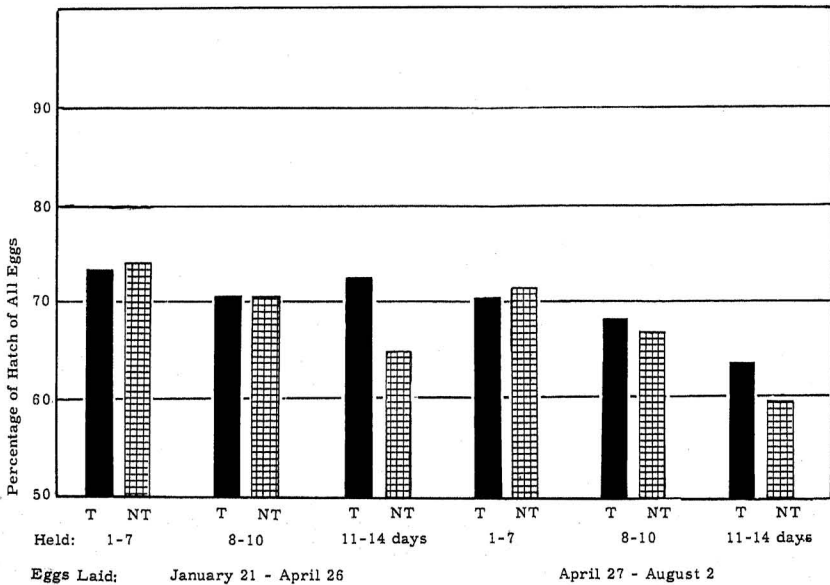


Figure 10. The effect of turning chicken eggs on the hatchability of eggs held at 55°F for 1 - 7 days, 8 - 10 days, and 11 - 14 days, 1948.

Observations (unpublished), made in another experiment at this station in which the effect of holding temperature was studied, showed that turning did improve hatching results of eggs held for only one to seven days at 32°F. and 90°F.

There was no difference between turned and unturned eggs during the holding period with respect to the percentage of eggs showing no development during incubation.

Eggs not turned during the holding period showed an increase in percentage of embryos dying from 2 to 18 days of incubation as the length of the holding period increased. The percentage of embryos dying from 2 to 18 days of incubation remained about the same through the holding period for eggs that were turned. Turned eggs held 10 days or more had significantly fewer embryos dying from 2 to 18 days of incubation than the unturned eggs held 10 days or longer.

The percentage of embryos dying after the eighteenth day of incubation tended to increase as eggs were held longer. There was no significant difference between turned and unturned eggs and the number of embryos dying after the eighteenth day of incubation.

Chicks from eggs turned during the holding period graded one per cent more in the top grade than those from eggs not turned during the holding period. There was little difference in the percentage of cripples and deformed chicks. Though our data do not cover the point, it is our opinion that any difference in the quality of the chicks was due to the lack of turning of eggs held longer than 10 days.

Is turning during the latter part of the holding period as beneficial as turning throughout the entire period? The results presented in Table 28 shed some light on this problem. They indicated that turning during the 5th to 13th, 8th to 13th and 10th to 13th days did improve the percentage of hatch of all eggs somewhat but that greater improvement resulted when the eggs were turned throughout the entire period (1 to 13 days). It is of interest to note that eggs set the day laid hatched 64.3% as compared to 68.2% for eggs held one to four days before setting.

Table 28.--The Accumulative Effect of Turning on Hatching Results With White Plymouth Rock Eggs Held More Than Five Days at 52°F. January 30 to March 26, 1950.

Days Held	Eggs Not Turned		Eggs Turned Daily		Eggs Turned Only During the Period Indicated	
	No. Set	Percentage of Hatch	No. Set	Percentage of Hatch	No. Set	Percentage of Hatch
Set day laid	258	64.3				
1-4	441	68.2	437	65.7		
5-13	405	55.6	405	61.0	540	58.9
8-13	233	54.6	232	60.3	381	54.9
10-13	145	51.7	145	60.0	311	55.6