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Effect of Month of Production on Reproductive Traits of Barred Plymouth Rock Parent Stock in the Humid Tropics

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ABSTRACT

Seasonal effects on reproductive performance of birds had been overblown in previous study with little or no mentioning of influence of individual month that comprised the season. It is imperative to understand the impact of each month in a season or year on the reproductive performance of birds for effective planning and productive management decisions. The main objective of this study, therefore, was to determine the effect of individual month of production on reproductive traits of Barred Plymouth Rock layer breeder hens. Data used for this study were collected from farm records kept between 2002 and 2005. Analyzed data showed that month of production significantly affected all the reproductive traits, and that coldest months, that is, June-September favored high egg production, fertility and hatchability rates, while hottest months, that is, October-May impacted negatively on birds' performance. In addition, mortality rate was low during coldest months but highest in the hottest periods. The month of July recorded the highest (peak) production levels for all the traits, while the lowest was observed in November. This study revealed that prevailing environmental temperature in individual month determines the productivity level of breeder hens, and hence the profit margin of the stockholders. Therefore, concerted efforts should be made towards massive production of fertile eggs during the aforementioned cool and favorable months in order to meet the increasing demand for day-old chicks by poultry farmers. Possible intervention to increase broiler chickens production is that producers should plan their re-stocking in such a way that the birds will commence egg laying at the onset of cold months in order to maximize the positive influence of these months on performance of breeder birds.

Key words: Breeder, egg, fertility, hatchability, month, mortality

INTRODUCTION

The fluctuating environmental temperature typical of tropical weather is a source of concern to poultry farmers especially breeder farmers in this country because of its negative effect on birds' reproductive performance (Olawumi, 2011). The differences in genetic make-up coupled with the birds' inherent abilities to adjust and adapt to fluctuating weather conditions are the major factors enhancing the reproductive performance of any breed of chickens reared in any production environment (Aganga *et al*., 2003). The two most important weather variables that have direct bearing on birds' activity are temperature and relative humidity. Research evidence had shown that throughout the whole range of practical environmental temperature, laying hens have physiological responses that affect their productive performance (Keener *et al*., 2006). Irshad *et al*. (2012) posited that it is not the degree of heat alone that causes distress to animals in the tropics but its combination with humidity and the duration of these conditions.

The relationship between ambient temperature and reproductive traits had been much studied in poultry. Olawumi and Ogunlade (2010) documented significant negative correlation between egg production and high temperature in layer breeders. In ostrich, Rozenboim *et al*. (2007) reported that egg production and weight decreased from naturally and experimentally high temperature. Previous researchers had documented that year, season and month of production have direct bearing on production and reproductive performance of animals (Chowdhury *et al*., 2004). The authors observed that individual month and season influenced the hatchability of duck eggs. In addition, significant effect of month on egg production (Ipek and Sahan, 2004; Wohr and Erhard, 2005; Elsayed, 2009), fertility and hatchability (Elsayed, 2009) had been reported in Ostrich. In chickens, Malau-Aduli *et al*. (2003) reported positive effects of age, year and season on egg production and mortality. In general, reproductive efficiency of birds depends on both genetic and non-genetic factors (Olawumi, 2011). Egg production, fertility and hatchability are important reproductive traits that determine the success of any chick production industry (Islam *et al*., 2002). These reproductive traits are lowly heritable, and are affected largely by environment such as nutrition, management practices, health status of the birds and farm hygiene (Olawumi, 2011).

Seasonal influence on egg production (Bawa *et al*. 2001; Olawumi, 2011), fertility and hatchability (Olawumi, 2007) and mortality (Bawa *et al*., 2001; Olawumi, 2007) had been documented in literature. Some of the negative and indirect effects of high temperature on birds' performance are reduced feed intake (Njoya and Piccard, 1994) and declining immune response (Dauda *et al*., 2006) of the birds to invading pathogens. Yolk formation in birds according to Elsayed (2009) is essentially a continuous process, while oviposition, ovulation and the formation of other egg components are discreet events within the cycle. The author posited that this later events are more susceptible to prevailing environmental temperature. Aside from the reasons already advanced, age of hens, egg size, shell quality, incubation temperature and relative humidity contribute to, and determine fertility and hatchability rates of a certain flock of breeder hens (Robinson *et al*., 1991; Olawumi, 2007).

The humid zone of Nigeria is characterized by high temperature and relative humidity. Information is limited in literature regarding the effect of individual month of production on egg production, fertility, hatchability and mortality rates of breeder hens in Nigeria. Most previous studies had focused mainly on effects of season which is broad and could be misleading. With this idea in view, present investigation therefore, was carried out to determine the effect of individual month of production on reproductive traits of Barred Plymouth Rock breeder birds reared for the production of commercial day-old chicks in Nigeria.

MATERIALS AND METHODS

Site of Study

Data on egg production, fertility, hatchability and mortality were collected from farm records of Ajanla Farms (CHI Ltd.), Ibadan covering a period from 2002 to 2005. Ibadan is situated at an elevation of 200m above sea level and lies about $7^0 28^1$ and $3^0 54^1$. The city enjoys two distinct seasonal periods namely, rain (May-October) and dry season (November-April). The minimum and maximum temperatures on average during the year are 20^0C and 30^0C, respectively.

Parent stock birds and their management

The exotic parent stocks studied were Barred Plymouth Rock (BPR) hens, and they were managed on the floor throughout the production period for natural mating at ratio 1male to 10females. The cocks were declawed to prevent injury during copulation, and were separated from the females during growing (rearing) period until about two weeks to the laying time. This method adopted was to prevent pre-cocious mating, and it afforded the cocks an opportunity to reach the prescribed weight and maturity. Management practices on the farm during the observed period were uniform. Cleanliness, bio-safety and bio-security measures were strictly adhered to, while vaccinations against viral diseases were administered as and when due. Fertility percent was determined on the candling (18^{th}) day, while hatchability percent was taken on the hatching (21^{st}) day.

Hatchery management

Temperatures and relative humidity during incubation were as follows:

a. Setting temperature- 99.75^0F (37.64^0C, 1-18days)
b. Setting humidity- 83%RH (1-18days)
c. Hatching temperature- 99^0F (37.22^0C, 19-21days)
d. Hatching humidity- 85%RH (19-21days)

Statistical Analysis

Data collected were subjected to analysis of variance (one way) using the General Linear Model (SAS, 2001), and the significant differences between means of months were determined by Duncan New Multiple Range Test of the computer package

The appropriate statistical model used for egg production, fertility, hatchability and mortality was:

$Y_{ij} = \mu + S_i + €_{ij}$

Y_{ij}= Observation of the j^{th} population, of the i^{th} month

μ= common mean

S_i= fixed effect of month (i=12)

$€_{ij}$= random errors assumed to be normally and independently distributed with zero mean and common variance.

RESULTS

Temperature and relative humidity readings for the period of study were presented in Table 1. Moderate and not too high temperature was recorded between June and October, while very high temperature was recorded during the remaining months. Relative humidity was low between November and March and higher in other months.

Table 2 demonstrates the effect of month of production on breeder hens' egg production. There was highly significant (P<0.001) effect of month of production on egg production in this flock. The month with peak egg production per hen per week was July (5.39±0.23eggs), while the lowest number of egg production per hen per week was recorded in November (3.76±0.20eggs).

Table 1. Average Temperature and relative humidity readings for the months

Months	Temperature (^{0}C)	Relative humidity (%)
January	26.65	59.05
February	28.91	64.04
March	29.4	67.06
April	27.55	75.56
May	27.32	75.85
June	25.71	79.45
July	24.87	81.05
August	24.48	83.23
September	25	79.83
October	25.86	78.31
November	27	71.35
December	26.73	60.28

Table 2. Least square means showing the effect of month on egg production

Factors	No. (weeks)	LSQ	±SE	P-value
January	18	4.60^{bc}	0.18	0.001
February	16	4.35^{c}	0.20	0.001
March	18	4.26^{cd}	0.18	0.001
April	13	5.02^{ab}	0.22	0.001
May	15	5.14^{ab}	0.20	0.001
June	12	5.15^{ab}	0.23	0.001
July	12	5.39^{a}	0.23	0.001
August	15	5.33^{a}	0.20	0.001
September	12	5.06^{ab}	0.23	0.001
October	12	4.86^{abc}	0.23	0.001
November	16	3.76^{d}	0.20	0.001
December	20	4.38^{c}	0.16	0.001

^{abcd} means along columns with different superscripts are significantly different

Similarly, month wise fertility of BPR breeder hens was presented in Table 3. There was highly significant (P<0.001) effect of month of production on fertility rate of breeder layers. The highest fertility rate was recorded in July, August and September, while the lowest was in December, January, February, March and April.

In this study (Table 4), there was highly significant (P<0.001) effect of month of production on hatchability of BPR breeder layers. Highest hatchability rate was recorded in July, August and September, while the lowest was recorded for December, February and March.

In the current study (Table 5), month of production has significant (P<0.001) effect on mortality rate of BPR breeder birds. Highest mortality rate was found in January and February, while the lowest rate was recorded in June, July, August and September.

Table 3. Least square means showing the effect of month on fertility

Factors	No. (weeks)	LSQ	±SE	P-value
January	16	78.74[d]	1.22	0.001
February	14	75.27[d]	1.34	0.001
March	18	74.92[d]	1.22	0.001
April	13	79.12[d]	1.40	0.001
May	15	83.85[c]	1.34	0.001
June	12	87.53[abc]	1.46	0.001
July	12	91.06[a]	1.46	0.001
August	15	89.99[a]	1.34	0.001
September	12	90.03[a]	1.46	0.001
October	12	89.12[ab]	1.46	0.001
November	16	85.67b[c]	1.46	0.001
December	20	76.01[d]	1.60	0.001

[abcd] means along columns with different superscripts are significantly different

Table 4. Least square means showing the effect of month on hatchability

Factor	No. (weeks)	LSQ	±SE	P-value
January	14	66.23[e]	1.63	0.001
February	14	60.83[f]	1.63	0.001
March	16	60.9[f]	1.43	0.001
April	13	71.46[d]	1.69	0.001
May	14	75.44[cd]	1.63	0.001
June	12	79.75[abc]	1.76	0.001
July	12	83.43[a]	1.76	0.001
August	14	80.81[ab]	1.63	0.001
September	12	80.51[ab]	1.76	0.001
October	12	76.93[bc]	1.76	0.001
November	12	71.61[d]	1.76	0.001
December	10	60.86[f]	1.93	0.001

[abcdef] means along columns with different superscripts are significantly different

DISCUSSION

In general, many factors influence the number of eggs produced in each month by breeder hens in this country. These include breed, weather, nutrition, obesity, health and physiological factors (Aganga *et al.*, 2003; Olawumi *et al*., 2008). The obtained results on egg production were similar to those reported in previous studies in ducks (Ipek and Saha, 2004; Wohr and Erhard, 2005; Elsayed, 2009) and in commercial layers (Malau-Aduli *et al.*, 2003). The month (July) with the highest egg numbers happened to be the month with lowest temperature range (24.48^0C), while the month (November) with the lowest egg production coincided with the month with highest temperature range (27^0C). This result confirmed previous findings that high temperature impacted negatively on the laying performance of hens (Olawumi and Ogunlade, 2010). The result also corroborates what was reported by Rozenboim *et al.* (2007) in Ostrich. The decrease in egg production in this study during hottest months was probably due to decrease in feed consumption by the hens as a result of heat load, thereby reducing the amount of nutrients available for production. The small amount of feed consumed was used for body maintenance. In this study, the most favourable months for egg production were April, May, June, July, August

and September, while the unfavourable months, that is, months with lowest egg production were October, November, December, January, February and March which incidentally happened to be the hottest periods in this country (Olawumi, 2007).

Table 5. Least square means showing the effect of month on mortality

Factor	No. (weeks)	LSQ	±SE	P-value
January	16	20^{ab}	2.07	0.001
February	14	23.43^{a}	2.24	0.001
March	16	14.81^{bc}	2.07	0.001
April	13	8.77^{cd}	2.32	0.001
May	14	9.21^{cd}	2.24	0.001
June	12	5.75^{d}	2.41	0.001
July	12	6.25^{d}	2.41	0.001
August	14	5.71^{d}	2.23	0.001
September	12	7.58^{d}	2.42	0.001
October	12	9.0^{cd}	2.42	0.001
November	11	6.73^{d}	2.16	0.001
December	18	10.78^{cd}	1.86	0.001

^{abcd} means along columns with different superscripts are significantly different

In a recent study which was comparable with this findings, Melesse *et al.* (2013) reported that hen-housed egg production decreased significantly in all heat-stressed genotypes compared with those at thermo-neutral environment. It is important therefore, that concerted efforts be made towards massive production of fertile eggs during the aforementioned favourable months in order to meet the increasing demand for day-old chicks by poultry farmers. However, our data showed that egg number per hen per month significantly ($P<0.05$) increased with the advancement of laying month, that is, each hen laid more eggs as the month progressed from commencement of laying to the end of production cycle.

It was observed that the months with highest fertility rate fell within the period with lowest temperature. Also, the months with lowest fertility rate coincided with hottest periods of the year in this country. The result of month's effect on fertility indicates that changes in weather conditions within a year significantly affected this trait, and that those months with lowest temperature range supported high fertility rate than hottest months. In agreement with this result, Jayarayan (1992) and Das and Ali (1999) observed lower fertility rate in summer compared to winter period. It is believed that fertility rate of breeder hens is a very important measure of their reproductive efficiency. According to Gowe *et al*. (1993), egg fertility is generally considered a trait of both parents, and their ability to interact and produce a viable zygote. The grave consequence of high temperature on fertility rate could be traced to reduced feed intake (quality and quantity), reduced mating activity and sperm production (quality and quantity). During hot weather conditions, birds eat less and are usually found clustering around drinkers than feeders in order to cool down their body temperature. In addition, males are also found to be heat-stressed, and unable to mate or sexually arouse the females. The combined effects of these factors result to poor or unimpressive fertility percentage, and this accounts for poor productivity of laying birds between months, within a year (Olawumi, 2007).

The hatchability result followed the pattern reported for fertility rate. The two traits are related, and are affected by both genetic and environmental factors. Months with highest hatchability rate happened to be the cold periods of the year, while the months with lowest

production were the hottest periods. And this confirmed previous observations that variations in weather conditions cause observed differences in hatchability rate within a year (Farooq *et al*., 2003; Chowdhurry *et al*., 2004; Olawumi, 2007). According to Sastry *et al*. (1996), temperature was the most critical factor for incubation, and the temperature affected both quantity and quality of hatch. The researchers posited that high incubation temperature results in embryonic mortality, particularly when there was high temperature during the last part of incubation period. The result of this study shows that the best time for hatching in this country falls within July-September, while appreciable and reasonable production could also be obtained in June and October.

With regard to mortality rate, months with highest deaths were the hottest part of the year in this country, while the coldest months (June-September) had the lowest mortality rate. The obtained result confirmed previous findings which found negative effect of high temperature on mortality rate (Bawa *et al*., 2001; Malau-Aduli *et al*., 2003). High mortality rate reported during the hottest periods of the year could be as a result of heat stress which lessened the immune response of the birds to weather fluctuations, thereby predisposing them to heat stroke or pathogenic organisms and eventual death.

CONCLUSIONS

The obtained results showed that month of production significantly affected the overall performance of BPR layer breeders in this country. The most productive months with greater production are June–September when the temperature appeared very low and conducive for increased reproductive activity of breeder hens. For increased production of day-old chicks, replacement pullets should be purchased in December or January so that the birds will commence egg laying in June or July when the weather appears favorable and conducive for good production.

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