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Interaction of breeds, years, age of bird and pen effects on hen day lay of three layer breeds and their adaptation in the derived Southern Guinea Savannah of Nigeria

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Abstract. Egg production of Haco black, Shaver's brown, Lohman brown and Olympia black were collected from production records at Big Bam commercial farm Makurdi from 1997 to 2004. The mean hen day lay of the breeds were estimated in percentages at 49-52, 56-60 and 69-73 weeks. The mean hen day lay of effects of breed by year and breed by pen by age of bird interactions were estimated. The hen day lay of Haco black by year interaction were low varied significantly ($P<0.05$) across the years; while that of Shavers brown were significantly higher and consistent. Olympia black and Lohman brown hen day lay due to interaction with year were also high with minimum variation across the years. The mean hen day lay due to effects of interaction of Haco black at 56-60 and 69-73 weeks by pen L_1, L_2, and L_3, were significantly lower than that at 49-56 weeks. The mean hen day lay due to effects of interaction of Shavers brown at 56-60 and 69-73 weeks by pen L_1, L_2, and L_3, were significantly higher than that at 49-56 weeks. The mean hen day lay of interaction of Lohman brown and Olympia black at 69-73 weeks by Pen L_1, L_2, and L_3, were significantly higher than that at 56-60 weeks. This result indicated that the response to the restrictions of the years and their effects on the strategies of aging of the breeds on their hen lay varied across the genetic groups. Haco black was more susceptible to this stress especially at the advanced age. Lohman brown and Olympia black were better than Haco black. Shaver's brown was superior in this trait as neither the restrictions of the years nor the strategies of aging affected its hen day lay. In order of fitness, Shavers brown, Lohman brown and Olympia black were most adapted to this region. Thus, Shavers brown which is better adapted to the prevailing environmental conditions in the Southern Guinea Savannah is recommended for poultry farmers in this locality.
Key Words: cage-position, hen-day lay, interaction, Guinea Savannah.

Introduction. The performance of a layer breed is the joint action of its genotype and the non genetic effects (environment) to which it is exposed (Systrad 1989). The genotype is a frame which restricts the performance to a given level, below which the performance is determined by the environment (Barlow 1981). Different genotype reacts differently in a given environment. The superiority of the given genotype is expressed when the environment is more favourable than that which is necessary to exploit fully, the potential of the inferior genotypes (Via & Lande 1987). All the genotypes are affected when the environment is worse than this though at different magnitude (Mather 1975). However, the superiority of the superior genotypes is realized regardless of the environmental conditions (Gillespie & Turelli 1989). Genotype by environmental interaction effect determines the productivity of layer breeds in a given region. The susceptibility or tolerance to detrimental environmental conditions determines the mean phenotypic fitness of a breed. Varied or unpredictable environment as the Nigerian case would reduce population mean fitness, performance and increases the risk of breed fragility (Lande & Shannon 1996), In the short-term, genotype by environmental interaction effect is more critical than genetic variability on production persistence of layer breeds in a given region (Lande 1988). In Nigeria, environmental conditions varied from on geographical area to another; so is their effect of interaction on the breed's performance (Dafwag 1987). Thus, there is need to provide information on environmental tolerance of common breeds that can tolerate pioneering environmental conditions in their localities. The study therefore intends to provide comparative information on the effect of breed by year and breed by age of bird by pen interaction on hen day lay of the breeds.

Materials and Methods. Data for this study were collected from Big Bam commercial poultry farm on egg production of Haco black, Shavers brown, Lohman brown and Olympia black layer breeds from 1997 to 2004.

Location. Big Bam commercial farm is situated at Makurdi Benue State, in the derived southern Guinea Savannah region of Nigeria. Makurdi is located between Latitude 6° 29′′, 8° 7′ North and Longitude 7° 44′′ and 9° 55′′ East. The climate is characterized by tropical weather conditions comprising of low altitude, low rainfall and moderate humidity at varying times of the year. There are two seasons, dry (November to April) and wet (May to October). Makurdi has an average rainfall that ranges from 800 to 1,500mm. The annual average temperature ranges from 21°C to 33°C and the average humidity also ranges from 45% to 68 percent.

Flock Management. The chicks were acquired at day-old and brooded on the farm. They were maintained on home mix chick mash formulated from soya bean cake, maize, rice bran, bone meal, salt and vitamin mineral premix, water was supplied ad-libitum for the first five weeks. Medication and vaccination schedules were carefully followed during brooding and rearing. At eight weeks, the home mix chick mash was replaced with home mix grower mash containing 16 percent crude protein and 4.07 Kcal/g metabolisable energy using the same initial ingredients. The birds were maintained on this diet until they were nineteen weeks of age. At twenty weeks, the birds were transformed to the cages in the laying pens. The home mix growers mash was replaced with home mix layers mash containing 56.27% nitrogen free extract, 90.95% ash, 3.98% crude fibre and 4.08% fats also formulated from the initial ingredients and fed at 0.125kg per day. Water was supplied ad-libitum throughout the laying phase. Feed was served twice a day at 5 hours GMT (6 am local time) and at 14 hours GMT (3.00 pm local time). Eggs were collected in the morning 7.00 hours GMT (8.00am local time) and at evening 15 hours GMT (4.00 pm local time).

Housing. The flock were housed in three pens designated as L_1 (pen I), L_2 (pen II) and L_3 (pen III). All the pens were built from cement block and were made of dwarf wall screened with wire mesh and zinc roof, the orientation was east to west. The distance between the pens was about 70m. The floor level varied from L_1 to L_3. In pen L_1, the floor level was elevated such that you climb up into the pen; the floor level window margin was low. There were two cages one each at either sides of the pen designated as L_1C_1 (cage I) and L_1C_2 (cage II) into which the birds were reared. The floor level roof margin was low. In pen L_2, The floor level was sunk down; such that you would have to descend down into the pen. The floor level window margin was high. There were three cages. Cage I (L_2C_1) followed by cage II (L_2C_2) in the middle and cage III (L_2C_3) at the opposing side. The floor level roof margin was very high. In pen L_3, the floor level was at ground level. Its floor level window margin was low. It also lies close to the open river Benue. Pen L_3 also contain three cages. Cage I (L_3C_1), Cage II (L_3C_2) middle cage and Cage III (L_3C_3).

Data Analysis. The hen-day lay of the breeds was estimated in percentage (number of eggs collected divided by number of birds housed multiplied by 100) at 49-52, 56-60 and 69-73 weeks. Mean hen-day lay of effects of breed by year and breed by pen by age of bird interactions and their standard error of means (SE) were also estimated using the models below. Duncan's multiple Range Test was used to separate means of effects that were significant.

$$Y_{ijk} = \mu + B_i + e_{ij}$$
$$Y_{ijk} = \mu + B_i + (By)_{ij} + e_{ijk}$$
$$Y_{ijkl} = \mu + B_i + (BPA)_{jkl} + {}_{eijkl}$$

Where:

Y_{ijkl} = observed hen day lay

μ = population mean

B_i = effect of breed (i= 1, 2, 3, 4)
e_{ijkl} = error assumed normally and independently distributed with mean zero and variance that of the population.
$(By)_{ij}$ = effect of interaction between breed by year.
$(BPA)_{jkl}$ = effect of interaction between breed by ben by age of bird.

Result and Discussion

Breeds by Years Interaction Effects. There where significant ($p<0.05$) effect of breed by year interaction on hen hen-day lay of the breeds. In 1997, 1998 and 1999, Haco black hen day due to breed by year interaction were least and significantly ($P<0.05$) different from that of the other breeds (Table 1). Shavers brown and Olympia black hen-day lay due to breed by year effects in 1997, 1998, 1999 and 2003 were not significant ($P>0.05$). The effect of year by breed interaction on hen-day lay of Shavers brown and Lohman brown in 1998 and 1999 were also not significant ($P>0.05$). Olympia black and Lohman brown hen-day lay in 1999, 2000 and 2004 were also not significant ($P<0.05$) (Table 1). The highest hen-day lay due to this effect were recorded in 2001 and 2002, (77.6 and 73.2 percent) for Haco black and Lohman brown in 2001 respectively and (76.7 and 69.0) percent in 2002 for Olympia black and Lohman brown respectively (Table 1). An increase in temperature that affected Lohman brown and Haco black resulting to a decrease in their hen-day lay, did not affect that of Olympia black and Shavers brown.

Table 1

Breeds and years interaction effect on hen day lay of Haco black, Olympia black, Shavers brown and Lohman brown at 50-55 weeks old

Breed	*Year*							
	1997	1998	1999	2000	2001	2002	2003	2004
HB	$52.3^a \pm 0.01$ (2136)	$49.6^a \pm 0.03$ (1981)	$52.6^a \pm 0.02$ (2356)	$58.5^a \pm 0.03$ (1628)	$77.6^a \pm 0.02$ (1782)	$58.2^a \pm 0.03$ (1354)	$64.4^a \pm 0.01$ (1900)	$61.75^a \pm 0.02$ (1249)
SB	$62.3^b \pm 0.00$ (3224)	$66.22^b \pm 0.02$ (1281)	$63.42^b \pm 0.02$ (1318)	$60.45^a \pm 0.00$ (3080)	$47.6^b \pm 0.00$ (6148)	$57.02^b \pm 0.00$ (6130)	$56.0^b \pm 0.00$ (5132)	$62.8^a \pm 0.02$ (1163)
OLPB	$63.4^b \pm 0.02$ (1021)	$76.3^c \pm 0.05$ (936)	$65.4^b \pm 0.03$ (1110)	$63.8^b \pm 0.02$ (1320)	$68.4^c \pm 0.02$ (1348)	$76.7^b \pm 0.01$ (2514)	$55.8^b \pm 0.01$ (2632)	$68.8^b \pm 0.01$ (2918)
LOHB	$69.3^c \pm 0.03$ (1018)	$64.5^b \pm 0.02$ (1239)	$58.6^b \pm 0.03$ (1240)	$68.6^b \pm 0.04$ (1129)	$73.2^b \pm 0.03$ (1008)	$69.0^c \pm 0.03$ (928)	$63.2^c \pm 0.02$ (1126)	$67.0^b \pm 0.08$ (1023)

a, b, c - Figures with different superscripts across the groups are significantly different. Figures in parenthesis are numbers of observations.

The lowest significant hen-day lay of Haco black by 1997,1998 and 1999 interaction may be related to the interactive effects between high temperature and relative humidity (27.82ºC, 52.67%, 29.59ºC, 50.92% and 28.14ºC, 54.75%) respectively (Makurdi 2005) on egg production. This may be due to the inability of Haco black to cope with thermal stress which depended on the black insulation provided by the bird coat, rate of feathering as well as its behavior to eliminate excess body heat. Webster & Wilson (1992) and Leng (1991) also reported the effect of domestic animals physiological behaviors in eliminating excess body heat on their production performance.

The non significant effect of year by Shavers' brown and Olympia black interaction on hen-day lay in 1997, 1999 and 2003 were possible by their favourable physiological reactions to the high temperature and relative humidity. This may be due to their superior genetic (additive and non additive) potentials that were expressed at higher levels than Haco black,that they overcame the restrictions in these years. Liljedahl et al (1984), Ledur et al (2003, 2000) also reported similar observations.

The significant difference in the hen-day lay due to breed by year interaction effect of Olympia black and Lohman brown in 1997 and 1998 was also understandable because, the increase in temperature from 27.82ºC and relative humidity of 52.67% to 28.39ºC relative humidity of 50.92% in 1998 (Makurdi 2005) reduced hen-day lay of Lohman brown from 69.3 to 64.5 percent while that of Olympia black increased from 63.4 to 76.3 percent. Thus Olympia black with superior additive and non additive genetic effect on this trait is more able to cope with thermal stress than Lohman brown whose inferior additive and non additive genetic effects on this trait made it susceptible to the increase in temperature. It will therefore be heat stressed, consume less feed and hence a fall in the egg production as observed. Johnson (1987) and Leng (1991) also reported significant effect of increased temperature on animal's ability to reduce body heat and its performance.

The highest hen-day lay recorded in 2001 and 2002 were due to low humidity of 48.83 and 47.17 percent (Makurdi 2005) respectively that enhanced body heat lost even at higher temperature by evaporative cooling. The reduced humidity exploited fully the genetic potentials of Haco black and Lohman brown on this trait. Lande & Shannon (1996) also reported that improved environmental conditions exploit the full potentials of a breed.

The significant higher hen-day lay of Shavers brown and Olympia black over that of Haco black and Lohman brown in 1998 (66.8 ± 0.01, 76.3± 0.00) 1999 (63.42 ± 0.02, 65.4 ± 0.01) and 2004 (62.8 ± 0.00, 68.8 ± 0.00) in the same years may be related to their superior additive and non additive genetic effects that enhanced their ability to cope with thermal stress and tolerated the increase in temperature (Makurdi 2005) with minimum restrictions on their genetic potentials in this trait. Engstrom (1992), Rahman (2002) and Lande (1992) also reported that the potentials of the better genotype is always expressed irrespective of environmental restrictions.

The significant higher hen-day lay of Haco black and Lohman brown in 2003 even at 32.53ºC (Makurdi 2005) over that of Shavers brown and Olympia black may be related to their stocking rate and the low humidity (46.75%) (Makurdi 2005) which renders heat dissipation by evaporative cooling through panting very effective. Farooq et al (2002), Awoniyi et al (2003) also reported that low stocking rate at low humidity enhances evaporative cooling and improved egg production. On the other hand, the low hen-day lay of Shavers brown and Olympia black in 2003 may be due to the cumulative effect of high stocking rate and the increased temperature, whose interplay enhances heat build up and thermal stress. Carew et al (1980), Lai & Kan (2000) also reported significant effect of interaction between high stocking rate, high temperature and humidity on hen-day lay of white leghorn hens and Tsainya layer ducks respectively.

Breed by Age by Pen Interaction Effects. There were interaction effects between the breed by age by pen conditions on hen-day lay performance. While Haco black tolerated pen L_1, L_2 and L_3 conditions at 48-52 weeks (Table 2). The same pen conditions reduced its performance significantly ($P<0.05$) at 56-60 and 69-73 weeks of age (Table 2). The hen day lay performance due to Olympia black by ages by pen interaction at 49-52, 56-60 and 69-73 weeks were however not significant ($P>0.05$) except in pen L_2 where hen day lay at 49-52 weeks differed significantly from that of other ages (Table 2). The hen-day lay of Shavers brown by 56-60 and 69-73 weeks interactions were highest and significantly ($P<0.05$) different from that at 49-52 weeks (Table 2). This same trend was also observed for Lohman brown by Age by Pen though at lower values.

The significant lower hen-day lay of Haco black due by age by pen effect at 56-60 and at 69-73 weeks of age compared to 48-52 weeks indicated that it additive genetic effects on this trait decreases with age. Thus its ability to tolerate environmental hindrance was greatly reduced with advancing age. This result agreed with the report of Ledur et al (2003). This also indicated that the economic production level of Haco black is short-lived especially under harsh environmental conditions.

The significant higher hen-day lay of Shavers brown due to breed by age by pen effects at 56-60 and 69-73 weeks compared to 48-52 weeks showed that it can maintain production at economic level longer than Haco black and even at advanced age. Olympia black and Lohman brown hen-day lay due to the above effects followed the trend observed on Shavers brown; the values were however lower than that recorded for Shavers brow. Ledur et al (2003) also reported this observation. This may be due to varied strategies of aging for each genetic group on this trait. Shavers brown tolerated the interactive effects without appreciable decline in egg production. It produces at economic level over longest period than Lohman brown and Olympia black under same stressful conditions.

Table 2

Breed by age by pen interaction effects on hen day lay performance of the breeds

Age	*Breed*		*Pen*	
		L1	*L2*	*L3*
	Shavers brown			
49-52	"	56.0^a±02 (1862)	60.0^a±.09 (3389)	62.0^a±0.12(2849)
56-60	"	74.0^b±0.12(5121)	68.0^b±0.02(5412)	57.0^a±0.01(3136)
69-73	"	78.0^b±0.01(4244)	68.0^b±0.03(1156)	74.0^b±0.00(5120)
	Lohman brown			
49-52	"	65.0^a±0.03(2840)	55.0^b±0.01(4233)	58.0^a±0.01(1222)
56-60	"	54.0^b±0.21(2134)	53.0^b±0.12(3528)	57.0^b±0.10(2229)
69-73	"	56.8^b±0.22(1948)	63.0^a±0.12(2114)	65.0^a±0.01(2231)
	Olympia black			
49-52	"	57.0^a±0.02(5110)	63.3^a±0.01(4396)	60.0^a±0.00(3386)
56-60	"	60.0^a±0.12(4111)	54.0^b±0.01(3149)	57.0^a±0.00(4008)
69-73	"	63.0^a±0.04(3259)	53.2^b±0.01(2212)	59.8^a±0.03(4010)
	Haco black			
49-52	"	75.0^a±0.02(31370)	69.0^a±0.02(3148)	76.0^a±0.01(1445)
56-60	"	53.0^b±0.02(3122)	65.0^a±0.01(2440)	55.0^b±0.02(1681)
69-73	"	48.0^b±0.01(3118)	43.0^b±0.02(2141)	45.0^c±0.03(1194)

a, b, c - Figures with different superscripts across the groups are significantly different (P<0.05). Figures in parenthesis are numbers of observation.

Conclusions. The interaction between the breed by year and breed by pen by age of birds affected their egg laying potentials at varied magnitude. Haco black becomes highly susceptible to environmental stress as it advances in age with a sharp decline in egg production. This was also true for Lohman brown though at low magnitude. An increase in environmental temperature that restricted the full exploitation of the genetic potentials of Haco black and Lohman brown on this trait did not restrict same in Shavers brown and Olympia black. A poorly designed pen aggravated the existing environmental stress which further restricted the birds potentials on hen day lay.

Recommendations. A well designed pen that enhances maximal ventilation is a prerequisite to maximal productivity of the layer industry. Any of these four breeds has the potential for egg production. The most favoured in order of fitness are Shaver's brown, Olympia black, Lohman brown and Haco black. If a laying flock of Haco black and Olympia black must be reared in the region, the stocking density must be low and extra management techniques to reduce heat build up and enhance feed intake must be encouraged.

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