

Effects of genotype and season on the productive performance of commercial egg-type chickens in the derived savanna zone in Nigeria



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Abstract

Twelve (12) month production records of two commercial egg-type chickens, Nera Black (NB) and Isa Brown (IB) reared on a commercial farm in Ilora, Oyo State, Nigeria were analysed to assess effects of season and genotype on their performance. The production record was sorted according to the two recognized major seasons: wet (April-September) and dry (October-March) in the study area. Besides, the each major season was further partitioned into two sub-seasons namely: early rainy season (ERS: April-June), late rainy season (LRS: July-September), early dry season (EDS: October-December) and late dry season (LDS: January-March). Results of data analysis showed that genotype had no significant effect ($P > 0.05$) on all the performance indices. Conversely, season significantly ($P < 0.05$) affected all the performance parameters evaluated and hens performed better in wet seasons compared with dry months. There was significant ($P < 0.05$) genotype by season interaction effect on egg production but not ($P > 0.05$) for other productive parameters. IB strain performed better in wet season most especially in LRS while NB hens had better performance in dry season. Results from this study indicated that regardless of the season, the two egg strains should be employed for commercial egg production but adequate measure should be taken to combat the adverse effect of thermal stress on the welfare and performance of layers in the study area most especially in LDS months. Discrepancies in genotype by season interaction suggest genetic basis to differences in performances and physiological abilities of the investigated egg-strains to cope with stresses emanating from change in season.

Key Words: Egg-strains, genotype, productive performance, seasons.

Introduction

Commercial egg production in Nigeria and other developing economies in warm and hot tropical environments are dominated by exotic strains that were developed and evaluated in temperate region under optimal rearing conditions. Unfortunately, their performances plunged in their new environment basically due to sub-optimal rearing conditions they were subjected to. Studies conducted on comparison of commercial egg layers either in controlled or natural environments under homogenous rearing condition revealed disparity/variations in their performances (Duduyemi, 2005; Mmereole *et al.*, 2007;

Yakubu *et al.*, 2007; Franco-Jimenez *et al.*, 2007).

Season has been identified as one of the most important factor adversely affecting poultry production in the tropics, not only in those reared under extensive management system, but also in those intensively reared without artificial regulation of microclimatic condition (Mahmoud *et al.*, 1996; Ayo *et al.*, 2007; Obidi *et al.*, 2008). Seasonal variation in rainfall, relative humidity (RH) and ambient temperature (AT) is experienced across various agro-ecological zones in Nigeria. Among these meteorological indices, ambient temperature has been studied widely and its effect on poultry performance has been

demonstrated in various studies (Mashaly *et al.*, 2004; Elijah and Adedapo, 2006; Franco-Jimenez *et al.*, 2007; Rozenboim *et al.*, 2007).

There are substantial empirical reports on seasonal effect on performance of poultry in Nigeria; and most of them demonstrated unequivocally that heat stress emanating from high ambient temperature (HAT) in dry season months adversely affected production parameters such as mortality rate, egg weight, egg quality, feed consumption and egg production of poultry compared to wet months (Guobadia, 1997; Yakubu *et al.*, 2007; Mmereole *et al.*, 2007; Oguntunji *et al.*, 2008).

Furthermore, the unprecedented expansion of commercial egg-producing farms in Nigeria coupled with continuous flooding of Nigeria poultry market with commercial egg-lines of diverse genetic backgrounds make it imperative to conduct systematic comparative study on the available strains in different agro-ecological zones. This is extremely important in order to ascertain suitability of these strains under prevailing harsh tropical environment with a view to identifying and recommending appropriate genotypes that are less susceptible to seasonal changes and meteorological indices in different agro-ecological zones.

This assertion was buttressed by Horst (1985 and 1989) that the permanent and biologically founded genetic-environment interaction can be employed to maximize the efficiency of poultry production in regions providing sub-optimal environments.

Studies directed to uncover interaction of season and various exotic genotypes commonly employed for commercial purposes in Nigeria are scanty. However, the few available ones revealed significant differences in responses of various commercial layer strains to different

seasons (Yakubu *et al.*, 2007; Mmereole *et al.*, 2007); thus suggesting interaction between the meteorological indices and genotypes concerned.

In order to reveal relationship existing between genotypes and rearing environments, it has been suggested that field tests under the natural conditions prevalent during different seasons may provide more useful information pertaining to specific climates than experiments in controlled-temperature chambers (Marthur and Horst, 1994). Natural environment are characterized by seasonal variations in temperature, relative humidity and daylight lengths, making birds that perform well in one environment to show impaired productivity in the other (Garces *et al.*, 2001).

The present study was therefore conducted to investigate influence of season and genotype on production parameters of two commercial egg-type chickens in a derived savanna agro-ecological zone in southwest Nigeria.

Materials and Methods

Study area

Data for this study consisted of a 12 month performance records (January – December 2007) of Folawiyo Farms Ltd., a reputable commercial poultry farm located at Ilora, Oyo State, Nigeria. The study area lies in a derived savanna agro-ecological zone in southwest Nigeria and has two major seasons: wet (April-September) and dry (October–March) seasons. However, in order to enhance precision in appraisal of seasonal effect on performance, the production season was further divided into four sub-seasons viz: early rainy season, ERS (April–June), late rainy season, LRS (July-September), early dry season, EDS (October –December) and late dry season, LDS (January – March) as earlier described

Table 1: Mean seasonal ambient temperature and relative humidity of the study area (January – December 2007)

Weather element	Season			
	Early rainy	Late rainy	Early dry	Late dry
Temperature (°C)	31.2 ±2.68 ^{ab}	29.8±1.19 ^a	33.7±0.33 ^b	35.00±1.75 ^c
Relative humidity (%)	60.9±10.00 ^{ab}	68.2±2.38 ^a	51.6±7.10 ^b	30.4±0.63 ^c

Source: Folawiyo Farms Ltd. Ilora, Oyo State.

^{abc}Means without common superscript within row are significantly different (P<0.05)

by Oguntunji *et al.* (2008).

Experimental flock and management

The experimental flock comprised of 8318 Nera Black (NB) and 5454 Isa Brown (IB) commercial layers aged 24 and 22 weeks, respectively at the beginning of laying. These birds were reared from day-old on deep litter before they were transferred to battery cages.

Besides, two pullets of each strain were randomly allocated into battery cages and were intensively reared in open-sided house.

The flock had unlimited access to fresh clean water and were fed commercial layer diet throughout the experimental period. Strict hygienic practices were carried out in the farm and normal routine management practices such as vaccination against infectious diseases, deworming, delousing, and debeaking among others were carried out on the hens.

Performance parameters and Weather records

Productive parameters evaluated were feed intake (g/bird/day), percentage hen-housed egg production, incidence of egg crack and mortality. All these variables were recorded daily except feed intake which was taken weekly. Mean seasonal meteorological records for relative humidity and ambient temperature during the experimental period were obtained from the meteorological unit of the farm and are presented in Table 1.

Statistical analysis

The data collected fitted 2-factor factorial

experiment using General Linear Model (GLM) procedure of SAS (2001) User's Guide with genotype and season as fixed effects. Significant differences between treatment means were assessed using Duncan's New Multiple Range Test option of the same software package.

The statistical model used in this study was:

$$Y_{ijk} = \mu + G_i + S_j + (GS)_{ij} + e_{ijk}$$

Where

Y_{ijk} = individual observation

μ = fixed overall mean

G_i = effect of genetic group ($i=1, 2$)

S_j = effect of season ($j=1\text{---}4$)

$(GS)_{ij}$ = effect of interaction between genotype and season

e_{ijk} = experimental error, assumed to be independently, identically and normally distributed, with zero mean and constant variance, i.e. $i.i.d(0, \sigma^2)$.

Results and Discussion

Genotype effect

Tables 2 and 3 show the effect of genotype on the production parameters of the investigated commercial egg-lines. There was no significant (P>0.05) effect of genotype on all the parameters investigated. This contradicts earlier reports by Duduyemi (2005), Yakubu *et al.* (2007), Franco-Jimenez *et al.* (2007) and Mmereole *et al.* (2007). Conversely, Mmereole *et al.* (2007) reported significant effect of genotype on egg production and mortality rate of four genotypes. A study

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Table 2: Results of the analysis of variance on effect of genotype, season and their interactions on performance of commercial egg layers

Parameter	Genotype (G)	Season (S)	G x S
Feed intake	-	*	-
Egg production	-	*	*
Mortality	-	*	-
Egg Crack	-	*	-

*Significant at $P < 0.05$

conducted in Northern Nigeria showed that Bovans Brown hens were superior to their Lohmann Brown counterparts in egg production, body weight, egg weight while Lohmann strain had higher livability records and feed intake (Yakubu *et al.*, 2007).

Seasonal effect

Tables 2 and 4 show the mean seasonal effect on feed intake, egg production, incidence of mortality and egg crack.

Season significantly ($P < 0.05$) affected all the performance indices.

Generally, superior performance in all the performance parameters were obtained in wet seasons compared to dry seasons.

Least mean feed intake reported for hot LDS agrees with previous studies conducted in Nigeria that feed consumption fell to its lowest ebb in the hot dry season (LDS) (Oguntunji *et al.*, 2008; Yakubu *et al.*, 2007). At higher temperature, thermal stress experienced by livestock impairs metabolic and enzymatic activities

Table 3: Effect of genotype on performance of commercial egg layers

Parameters	Genotype	
	Isa Brown	Nera Black
Feed intake (g/b/d)	115.50 ± 7.70 ^a	113.83 ± 6.30 ^a
Egg production (%)	64.33 ± 8.52 ^a	64.41 ± 8.15 ^a
Mortality (%)	3.13 ± 2.81 ^a	2.90 ± 2.47 ^a
Egg crack (%)	0.09 ± 0.06 ^a	0.08 ± 0.05 ^a

^aMeans with common superscript within row are not significantly different ($P > 0.05$)

Table 4: Effect of season on performance of commercial egg layers

Parameters	Seasons			
	ERS	LRS	EDS	LDS
Feed intake (g/b/d)	113.17 ± 3.40 ^{ab}	119.33 ± 2.02 ^a	120.50 ± 0.87 ^a	105.67 ± 7.51 ^b
Egg production (%)	70.54 ± 6.05 ^a	71.57 ± 3.52 ^a	59.70 ± 3.59 ^b	55.66 ± 3.94 ^b
Mortality (%)	2.12 ± 1.33 ^b	1.52 ± 0.08 ^b	2.33 ± 0.27 ^b	6.08 ± 4.26 ^a
Egg crack (%)	0.06 ± 0.01 ^b	0.08 ± 0.01 ^b	0.16 ± 0.06 ^a	0.06 ± 0.02 ^b

^{ab}Means along the same row with different superscripts are significantly different ($P < 0.05$).

connected to digestion hence reduced appetite and feed intake (Elijah and Adedapo, 2006). Furthermore, it has been suggested that reduced feed intake during HATs might probably be one of the physiological responses employed by heat-stressed chickens to alleviate increased body heat load associated with feed intake in dry season (Oguntunji *et al.*, 2008). Withers (1992) and Sharifi *et al.* (2010) buttressed these reports further that heat-stressed birds reduced feed consumption in order to lower the thermogenic effects associated with absorption, assimilation and utilization.

Higher egg production in wet season (ERS and LRS) in contrast to dry season (EDS and LDS) is consistent with similar studies conducted elsewhere in Nigeria (Guobadia, 1997; Elijah and Adedapo, 2006; Yakubu *et al.*, 2007; Oguntunji *et al.*, 2008) where superior egg production in wet months was attributed to lower ambient temperature and higher feed intake.

Reduced feed intake of thermally-stressed hens has been implicated in drop of egg production in various studies (Mashaly *et al.*, 2004; Elijah and Adedapo, 2006; Franco-Jimenez *et al.*, 2007; Oguntunji *et al.*, 2008). However, these reports were at variance with the performance of the egg-

strains under study putting into consideration egg production and feed consumption records in EDS in this study. Significantly lower egg production in EDS in spite of higher feed intake in contrast to wet season records suggests possibility of poor efficiency and utilization of the calorie intake thus suggesting some other underlying factors apart from feed intake to be responsible for decline in egg production of the investigated strains in dry season months.

Thermally-induced endocrine imbalances resulting in depressed plasma reproductive and elevated stress indicator hormones might have contributed to low egg production of heat-stressed hens in hot seasons as observed in this study. Previous studies have shown that reduced circulating plasma concentrations of reproductive hormones such as follicle stimulating hormone, luteinizing hormone and ovarian steroids (progesterone, estradiol, testosterone) in thermally-stressed female poultry (chicken and turkey) compared to their counterparts in thermoneutral environments resulted in reduced egg production (Rozenboim *et al.*, 2004; Rozenboim *et al.*, 2007).

Significant effect of season on mortality of hens in this study agrees with previous

Table 5: Effect of genotype and season interaction on performance of commercial egg layers

Parameter/Season	Genotype								G x S
	Isa Brown				Nera Black				
	ERS	LRS	EDS	LDS	ERS	LRS	EDS	LDS	
Feed intake (gb/d)	113.3±4.71 ^b	122.00±1.41 ^a	121.00±1.41 ^a	105.67±6.13 ^b	113.0±1.41 ^b	116.67±2.36 ^{ab}	120.00±0.00 ^a	105.67±6.13 ^b	114.66±2.29 NS
Egg production (%)	71.04 ±3.33 ^a	73.33±2.45 ^a	56.45±4.29 ^b	56.49 ±2.30 ^b	70.03 ±6.72 ^a	69.80 ±3.29 ^a	62.93±1.42 ^{ab}	54.82 ±7.27 ^b	64.36±2.69 S
Mortality (%)	2.29±1.19 ^b	1.45±0.25 ^b	2.36±0.18 ^b	6.41 ±3.89 ^a	1.93 ±0.99 ^b	1.59 ±0.34 ^b	2.30±0.25 ^{ab}	5.75 ±3.49 ^a	3.01±0.68 NS
Egg crack (%)	0.0±0.01 ^b	0.06±0.03 ^b	0.17 ±0.03 ^a	0.08 ±0.02 ^b	0.06 ±0.01 ^b	0.09 ±0.03 ^{ab}	0.14±0.06 ^a	0.05±0.0 ^b	0.91±0.17 NS

^{abc} Means along the same row with different superscripts are significantly different (P<0.05).

G x S – Genotype by Season interaction

NS- Not significant

S – Significant

studies in tropical environment (Guobadia, 1997; Elijah and Adedapo, 2006; Mmereole *et al.*, 2007; Yakubu *et al.*, 2007; Oguntunji *et al.*, 2008). The highest mortality rate recorded in dry season months is in agreement with Yakubu *et al.* (2007) and Oguntunji *et al.* (2008) but at variance with Guobadia (1997) and Mmereole *et al.* (2007) in studies conducted under tropical environment in Nigeria. Yakubu *et al.* (2007) attributed higher mortality rate in dry season to deleterious effect of thermal stress while Guobadia (1997) and Elijah and Adedapo (2006) submitted that higher incidence of mortality in wet season may be attributed to high moisture content which tends to favour pathogenic and parasitic proliferation and infections.

Considerable empirical reports demonstrated that elevated environmental temperature coupled with heat stress exerted detrimental effects on immune and antibody responses of poultry (Zulkifi *et al.*, 2000; Mashaly *et al.*, 2004) and does exacerbate effect of some poultry diseases such as pasteurellosis, coccidiosis, and Newcastle (Simon, 2001). This might probably be one of the salient factors responsible for exceptional highest incidence of mortality of laying hens in LDS regarded as the most stressful for birds in the study area. Oguntunji *et al.* (2008), corroborated these reports that thermally-stressed environment could adversely affect hormonal balance thereby resulting in alteration and reduction in potency of the disease-fighting mechanism involved in immunoresponse of heat-stressed birds to parasitic and pathological proliferation and infections which consequently resulted in higher mortality rate of heat-stressed birds. Best eggshell quality (lowest egg crack incidence) in the hottest season (LDS) in this study is inconsistent with recent studies

conducted in Nigeria (Yakubu *et al.*, 2007; Oguntunji *et al.*, 2008).

Some investigators have ascribed poor shell quality of chicken hen under HATs to low feed intake (Mashaly *et al.*, 2004; Elijah and Adedapo, 2006; Oguntunji *et al.*, 2008) however, correlation of calorie intake and egg crack records across seasons in this study is at variance with these reports. It is incredible that highest incidence of egg deformity in EDS paralleled season with highest feed intake.

It could be postulated that higher endogenous thermal load in the body in the dry season months impairs the metabolic pathways involved/connected with feed digestion, assimilation and absorption thereby limiting utilization of the ingested nutrients needed for formation of good shell quality hence, higher incidence of egg crack.

Furthermore, several acid-base imbalances have been observed in birds raised under HAT particularly respiratory alkalosis (Balnave and Brake, 2005; Franco-Jimenez *et al.*, 2007) which in turn affects egg shell quality via reduction in the amounts of CO₂ and HCO₃⁻ in blood which are required by the shell gland to support shell formation (Etches, 1996) hence higher incidence of egg cracks. Mongin (1968) substantiated these reports that the first restrictive factor of shell formation was the calcium and the second factor was the carbonate ion so the breakage observed in egg shell in hot weathers is due to reduction in the amount of carbonate ion available for egg shell formation. Besides, Chauhan and Roy (2007) attributed poor shell quality in hot season to inactiveness of egg shell forming enzyme present in the uterus and that vitamin D₃ needed for synthesis of calcium-binding protein which transports calcium and phosphorus in the body can not be changed properly into active form even if

adequate in the diet due to HS thus resulting in higher incidence of poor shell quality at HATs.

Nevertheless, physiological mechanism responsible for low incidence of egg crack in the most stressful season (LDS) contrary to previous studies conducted in northern (Elijah and Adedapo, 2006; Yakubu *et al.*, 2007) and southern (Oguntunji *et al.*, 2008) Nigeria is not clearly understood.

Genotype x season interaction

There was significant ($P < 0.05$) genotype-season interaction effect on egg production but not ($P > 0.05$) for feed intake, incidence of mortality and egg deformity (crack) (Tables 2 and 4). Non-significant interaction between the season and genotypes in respect of performance parameters with the exception of egg production in this study is contrary to earlier report by Yakubu *et al.* (2007) whereby all productive parameters investigated were significantly affected. In addition, absence of interaction on mortality disagreed with Mmereole *et al.* (2007) who reported otherwise. Non conformity of the result of the present study may be adduced to differences in the breeds/genotypes involved, management practices, climatic conditions and age of the hens among others. Nevertheless, significant interaction effect observed only on egg production confirms earlier assertion by Cole *et al.* (2000) and Boettcher *et al.* (2003) that for non productive traits, genotype-environment interaction are virtually non-existent.

Seasonal effect on the genotypes indicates further that IB hens had marginal higher egg production in wet season while NB took the lead in dry months. Further comparison indicated that highest difference (10.33%) in egg production between the genotypes was recorded in EDS in favour of NB.

The interaction between genetic group and

season was most evident as season changes from wet (LRS) to dry season. The significant change in ambient temperature and relative humidity between LRS and EDS was accompanied with significant ($P < 0.05$) 23% plunge in egg production for IB in contrast to marginal ($P > 0.05$) 9.59% drop for NB in the same period. Furthermore, genotype-season interaction effect was so pronounced ($P < 0.05$) on IB strain between LRS and EDS to the extent that thermal stress induced sharp and permanent fall in egg production throughout dry season compared to gradual decline for NB.

The observed differences in their responses to changes in environmental conditions (elevated ambient temperature and low relative humidity) most especially in dry months are pointers to genetic differences in their physiological ability to thrive under adverse environmental conditions. NB strain appears to be hardier, thermotolerant, physiologically more stable and less vulnerable to the prevailing stressful meteorological conditions than IB counterpart.

Furthermore, in spite of non-significant interaction between genotype and season on livability and eggshell quality, some differences were observed in their responses to seasonal changes. Though marginal, IB strain had poorest survival rate and eggshell quality in dry season compared with NB. Furthermore, IB hens had best performance in LRS than NB in these traits. Their performances in respect of calorie intake followed the same trend.

This trend of performance substantiates previous observation assertion in this study on GE effect on egg production that IB strain is more physiologically sensitive to climatic stress (i.e. higher AT and low RH) of dry season.

Conclusion

Comparable overall performances of the investigated strains in parameters evaluated indicate their suitability for commercial egg production in derived savanna agro-ecological zone.

The characteristics poor performance of the investigated commercial layers in dry months is a pointer to the need to orientate poultry farmers on the need for dietary, prophylactic and managerial manipulations in dry season (most especially in LDS) in order to minimize adverse thermal effects on performance of their flocks.

Significant interaction between season and genotypes on egg production of the genetic groups under study suggests the feasibility of exploiting genetic differences in thermo tolerance of egg-strains as an innate antidote to heat stress in developing countries located in tropical environments where capital intensive temperature-regulating measures is beyond the reach of poultry farmers.

Nevertheless, based on genotype-interaction effect on production parameters investigated most especially on egg production, a more reasonable conclusion would be that NB strain will perform better in the drier climate of Northern Nigeria while IB will thrive better in wet humid climate of Southern Nigeria.

References

- Ayo, J.O.O., Owoyele, O.O. and Dzenda, T. 2007.** Effects of ascorbic acid on diurnal variation on rectal temperature of Bovan Nera pullets during the harmattan season. *Int. J. Poult. Sci.* 6: 612-616.
- Balnave, D. and Brake J. (2005).** Nutrition and Management of heat-stressed pullets and laying hens. *World's Poult. Sci. J.* 61: 399-406.
- Boettcher, P. J., Fatehi, J. and Schutz, M.M. 2003.** Genotype x Environment Interaction in conventional versus pasture-based dairies in Canada. *J. Dairy Sci.* 86: 383-404.
- Chauhan, H.V.S. and Roy, S. 2007.** Nutritional Diseases. *In: Poultry Diseases Diagnosis and Treatment.* 3rd Ed. New Age International (P) Ltd., Publisher New Delhi \110002 PP. 172.
- Cole, N. A., Brown, M. A. and Phillip, W.A. 2000.** Genotype x Environment Interaction on blood constituents of Angus, Brahma and Reciprocal cross cows and calves grazing common Bermunda grass or endophyte infected tall Fescue. *Agric. Res. Services.* pp 1-12.
- Duduyemi, O. A. 2005.** Evaluation of egg performance of two strains of Bovan chickens (Bovan Brown and Bovan Nera) in the tropics. *Proc. 1st Nigeria International Poultry Summit*, Feb. 20 – 25, Ota Ogun State, Nigeria, pp. 35-38.
- Elijah, O.A. and Adedapo, A. 2006.** The effect of climate on poultry productivity in Ilorin, Kwara State, Nigeria. *Int. J. Poult. Sci.* 5 (11): 1061-1068.
- Etches, R.J. 1996.** *Reproduction in Poultry.* CABI, Oxford, UK.
- Franco-Jimenez, D.J., Scheideler, S.E., Kittok, R.J., Brown-Brandl, T.M., Robeson, L.R., Taira, H. and Beck, M.M. 2007.** Differential effects of heat stress in three strains of laying hens. *J. Appl. Poult. Res.* 16: 628-634.
- Garces, A., Casey, N.H. and Horst, P. 2001.** Productive performance of naked neck, frizzle and dwarf laying hens under natural climates and two nutritional treatments. *S.Afri. J. Anim. Sci.* 31(3): 174-180.
- Guobadia, E.E. 1997.** The effect of

- seasonal variation on performance of egg-type poultry: A case study of Mitchell Farms, Mosogar, Delta State, Nigeria. *Nig. J. Anim. Prod.* 24(2): 101-105.
- Horst, P. 1985.** Effect of genotypexenvironment interactions on efficiency of improvement of egg production. In: Hill, W.G., Manson J. M. Hewwit, D. (Eds.) Poultry Genetics and Breeding. Bri. Polult. Sci. Ltd., Longman Group, Harlow, UK. Pp. 147-156.
- Horst, P. 1989.** Native fowls as a reservoir for genomes and major genes with direct and indirect effects on the inadaptability and their potential for tropically oriented breeding plans. *Arch. Geflugelk.* (53): 93-101.
- Mahmoud, K. Z., Beck, M. M., Sheideler, S. E., Forman, M. F., Anderson, K. and Kachman, S. D. 1996.** Acute high environmental temperature and calcium-estrogen relationships in the hen. *Poult. Sci.* 75: 1555-1562.
- Mashaly, M.M., Hendricks. G.L., Kalama, M.A., Gehad, A.E., Abbas, A.O. and Patterson, P.H. 2004.** Effects of heat stress on production parameters and immune response of commercial laying hens. *Poult. Sci.* 83: 889-894.
- Mathur, P. K., and Horst, P. 1994.** Genotype by environment interactions in laying hens based on relationship between breeding values of sires in temperate and tropical environments. *Poult. Sci.* 73: 1777-1784.
- Mmereole, F.U.C., Bratte, L. and Omeje, S.I. 2007.** Genotype and season interaction effects on the laying mortality rates of the Nigerian local chicken, the Barred Plymouth Rock and their crosses. *Int. J. Poult. Sci.* 6 (12): 892-894.
- Mongin, P.E. 1968.** Role of acid-base balance in the physiology of egg-shell formation. *World's Poult. Sci. J.* 24: 200-230.
- Obidi, J.A., Onyeanus, B.I., Rekwot, P.I., Ayo, J.O. and Dzenda, T. 2008.** Seasonal variations in seminal characteristics of Shikabrown breeder cocks. *Int. J. Poult. Sci.* 7(12): 1219-1223.
- Oguntunji, A.O., Aderemi, F.A., Lawal, T.E. and Alabi, O.M. 2008.** The influence of seasonal variation on performance of a commercial laying strain in a derived savanna environment in Nigeria. *Nig. Poult. Sci. J.* 5(2): 67-74.
- Rozenboim, I., Mobarky, N., Heiblum, R., Chaiselha, Y., Kang, S.W., Biran, I., Rosenstrauch, A., Sklan, D. and El-Hawani, M.E. 2004.** The role of prolactin in reproductive failure associated with heat stress in domestic turkey. *Biol. Reprod.* 48: 1246-1250.
- Rozenboim, I., Tako, E., Gal-Garber, O., Proudman, J.A. and Uni, Z. 2007.** The effect of heat stress on ovarian functions of laying hens. *Poult. Sci.* 86: 1760-1765.
- Salimonu, L.S. 2004.** Basic Immunology for Students of Medicines and Biology. 2nd ed. Salimonu L.S. ed. College Press and Publishers Limited, Ibadan. Oyo State, Nigeria. pp. 199-200
- SAS Institute, 2001.** SAS® Users' Guide. Version 8.2. SAS Institute Inc., CARY, NC.
- Sharifi, A.R., Horst, P., Simianer, H. 2010.** The effect of naked neck gene and ambient temperature and their interaction on reproductive traits of heavy broiler dams. *Poult. Sci.* 89: 1360-1371.
- Simon, S.M. 2001.** Enhancing production at high ambient temperature. World

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- Poultry Magazine on Production Processing and Marketing, Vol. 11, Vol. 17, 23-24.
- Withers, P.C. 1992.** Animal energetics. *In: Comparative Animal Physiology.* Saunders College Publishing, New York, NY pp.108
- Yakubu, A., Salako, A.E. and Ige, A.O. 2007.** Effects of genotype and housing system on the laying performance of chickens in different seasons in the semi-humid tropics. *Int. J. Poult. Sci.* 6 (6): 434-439.
- Zulkifi, I., Norma, M.T., Israf, D.A and Omar, A.R. 2000.** The effect of early age feed restriction on subsequent response to high environmental temperatures in female broiler chickens. *Poult. Sci.* 79: 1401-1407.

Received: 2nd November, 2011

Accepted: 6th December, 2012